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Cultivating the Scrap Heap.

Of old "The Engineer," of London, was the representative and exponent of everything that was British in engineering. Nothing that came from without the British Isles was of much account in its eyes, while of English products it, not many years ago, summed up its view of things by saying (we quote from memory): "The best of everything is still made in England, and those who want the best must come to us to supply their wants."

This was perhaps the culmination of "The Engineer's" state of complacency, and not long after it appeared the export movement in American machinery began to assume importance. "The Engineer," we are bound to say, showed a most commendable state of fairness, and even of appreciation of these products, and even gave its readers some pretty severe lectures on the situation. When the Atbara bridge incident was fresh, it went so far as to indulge in some criticisms of English engineers and engineering methods which were almost savage.

Of late we have been pained to note a decided back-sliding tendency on the part of our contemporary which seems to be coming to the conclusion that there isn't to be much of a flood after all.

In its issue of August 31 it concludes that, at bottom, the differences between American and English methods are due to environment, that transplanting could lead to no good results, and that, indeed, transplanting is impossible. The more progressive methods and more modern equipment of American works are thus accounted for:

"Our old works, our largest and most famous, are not built as they now exist from set intention. They were started in days when the huge proportions which mechanical engineering would attain were unforeseen, and when money was far less plentiful than it is now. They are antiquated in arrangement and design, but not more so than hundreds of American works will be fifty years hence if mechanical engineering spreads with such totally unforeseen rapidity in the next half century as it has done in that just coming to a close. And what will the owners do then—the third generation of owners—if they suddenly awake to the fact that a new competitor with radical notions has arisen to teach them the way they should go? Will they utterly cast out the ways of their fathers and grandfathers—will they be able to stamp out tradition and overcome hereditary ideas and spring up fresh and green from their ashes? No; and a thousand times no. They will do what England is doing. They will make the best use of the means they have at hand. They will modify and renew just as our manufacturers do now, but with caution and discretion, not with the immoderate haste which marks some of their movements to-day. That restless striving for the foremost place will be a nightmare of the past."

We are not prophets, and we do not pretend to say where the scepter of industrial supremacy will be found fifty years hence; but this quotation illustrates a fatal misconception of the conditions under which American methods have been developed. "The Engineer" seems to think that the typical American works have been planned complete upon a fresh sheet of paper, and that they have not had to face the problem of making "the best use of the means they have at hand." As an illustration of the real facts, we may mention the metallurgical and allied industries, in which some of the greatest American triun phs have been secured, as one in which this subject has been just as acute here as in England, and the Atbara bridge incident was the natural outgrowth of the different decisions arrived at in the two countries. In England the decision was to keep the old machinery turning over as long as it could be made to do its work. With us the decision was to make scrap of it as soon as a newer machine could be found which would produce sufficient increase of product to pay the required interest on the investment. And be it observed, the fundamental conditions were more favorable to frequent renewals in England than here, for until recently rates of interest have been uniformly lower there than here, while the cost of machinery there has called for a smaller outlay for a given equipment. In our rolling mills and steel works it is, we believe, a conclusion to which engineers have arrived that provision must be made for renewing them *in toto* every ten years, and, in point of fact, we not long ago saw a rolling mill (by which term we now mean a set of rolls with its attached engine and appurtenances) which was in process of demolition and on its way to the cupola. That mill, we were told, had been built but five years before, to be, as it then was, a strictly modern and up-to-date mill, but the progress of improvement had made its demolition a necessary measure of economy.

This incident illustrates the American view of such matters. Not all American works have been so managed, but those that have not have been crowded to the wall by those that have. And it may be predicted with entire confidence that the process that has been at work between individual establishments will also operate between nations. It is a matter of easy proof—in fact, it is almost self-evident—that the American practice leads to the best use of capital, as well as of labor, and that it must survive.

The English idea seems to be to regard a machine, once bought, as a permanent investment, or at any rate as one which is to be extinguished only by the operation of a suitable depreciation charge applied year by year. We may arrive at this point of view some time, but if we do, it will be

because of a radical change in the national character, and not because we have a plant of old machinery to deal with and must "make the best use of the means at hand."

Conspiracies as Viewed in Massachusetts.

An editorial in our No. 30, upon the "Right of Contract in Organizations," showed the advanced position recently taken by one of the higher courts in New York State, upon the conspiracy question—specifically upon the right of a labor union to seek to procure the discharge of men belonging to another union, under threat of striking. The court held that this was not illegal, and in its opinion made what seemed little short of an unqualified statement that an act which is lawful for a man individually is lawful for men acting jointly, thus largely doing away with the old ideas regarding "conspiracies." It may be of sufficient pertinence to note here that a New York lawyer of our acquaintance happened, about that time, to have a case in which this question was involved and in which he was relying upon former precedents, adverse to conspiracies to win the action. The editorial came under his notice before any other report of the case and the new decision as set forth cast such a different light upon his client's suit that he remarked he thought he should have to let it drop.

In Massachusetts a decision has lately been rendered by the Supreme Court as a result of a contention between two labor unions, of much the same nature as in the New York case before commented on. In the New England State, however, an opposite and more conservative view has been taken by the majority of the court. A certain labor union had attempted to boycott another by informing the employers that members of a rival organization were non-union men, which was understood to imply a threat of striking if members of the latter union were still employed. The court granted an injunction against the men making the threats and characterized their action as "intolerable and inconsistent with the spirit of our laws," "malicious," "unlawful" and a "conspiracy."

A dissenting opinion, however, was rendered by Chief Justice Holmes, who is a son of Oliver Wendell Holmes, and who took a view analogous to that of the New York court. He declared that, in his opinion laborers may lawfully employ such means to secure that unity of organization which is necessary to make the contest of labor effectual. It is lawful, in his opinion, for a body of workmen "to try by combination to get more than they are now getting, although they do it at the expense of their fellows, and to that end to strengthen their union by the boycott and the strike."

We have, therefore—if we assume the Appellate Division holding in New York to lay down the present law prevailing in that State—two of the States of the Union whose legal decisions are among the most influential, at variance upon a question vital to the interests of union labor and of employers. Which of the two will be followed in other jurisdictions remains to be seen; but if we regard Massachusetts as naturally representative of our conservative States, it would seem fair to pronounce New York not beyond the average as a radical one; so it is not improbable that the New York position will be endorsed by the courts in other parts of the country.

News-stand Sales of the "American Machinist."

Occasionally one of our readers who is away from home wants a copy of the "American Machinist," and hies him to a news-stand, only to be told that the paper is taken only on order and no extra copies are to be had. Sometimes the newsdealer volunteers the information that the sales of the paper are falling off.

A few years ago, when the paper was returnable, we found that about half the number taken by newsdealers were returned, and had been for years. We not only lost the cost of producing these papers, but were obliged to pay the return freight charges.

Investigation showed a very steady sale everywhere, and when the return privilege was discontinued, the average news-stand sales for the next year were *above* what they had been under the unlimited return plan.

We are convinced that the transient sales do not amount to 1 per cent. of the extra papers needed to supply the news-stands of the country with returnable copies. We can hardly afford to carry this expense to satisfy an occasional friend who wants the paper away from home, however much we would like to accommodate him. Both the subscription list and actual sales on the news-stands are now above the average in the previous history of the paper.

Legal Notes.

BY WM. MARSTON SEABURY.

EMPLOYER HELD NOT RESPONSIBLE FOR "DETAIL ACT" OF SUPERINTENDENT.

C. R. Remington & Son Company were manufacturers of paper and wood pulp at Glenpark, N. Y. It became necessary to install certain machinery in their factory, which involved the construction of various steam pipes, one of which was a small "tee pipe," which connected the main pipe with the boiler-room. To remedy a leak in a lateral pipe a valve was opened in a 2-inch pipe near the "tee pipe," with the result that a pounding noise, known as "water hammer," was heard in the main pipe; and upon the valve being closed by the superintendent (who had opened it) the "tee pipe" burst, emitting such quantity of steam as to cause the death of one Meeker, who was in company with the superintendent and employed by the same company.

Action was brought against the company by Meeker's representative to recover damages for his death, and a judgment was rendered in favor of the plaintiff by the New York Supreme Court, Jefferson County. The plaintiff contended, among other things, that the defendant's negligence which caused Meeker's death consisted in the act of the superintendent in opening the valve, which caused the "water hammer," which, it was claimed, ultimately "burst or split the tee." The Appellate Court held that the act of the superintendent in opening the valve was as the defendant claimed, a mere detail act, and not one performed by him as the representative of his employers, and that as he was a co-servant of Meeker, there could be no recovery. (99 St. R. 1116.)

ACCIDENT IN WORN-OUT COTTON-DRYING APPARATUS.

While Standtke was employed by the Swits Conde Company and engaged in the operation of a cotton-drying machine, he received injuries, to recover damages for which he brought suit in the New York Supreme Court, in Oswego County.

It appeared that the plaintiff had been in the employ of the Swits Conde Company for nineteen months prior to the action, and had used the machine at which he was injured during that time.

It further appeared that the apron of the machine—the function of which was to distribute the cotton—was old and worn and in an improper condition, and that for this reason it failed to perform the work required of it. The cotton became clogged in the rollers, and as Standtke was endeavoring to extricate it, his left hand was drawn between the rollers and was so badly lacerated that amputation was necessary.

The plaintiff received a judgment in his favor, which, on appeal, was reversed; the Appellate Court holding that it was error for the Trial Court to refuse, upon all the evidence in the case, to dismiss the plaintiff's complaint. (99 St. R. 942.)

RISK FROM DEFECTIVE PLANT NOT ORDINARY "RISK OF THE EMPLOYMENT."

The Bath Gas & Electric Company employed a man by the name of Arthur J. Frye as a fireman, whose duty it was to "slice" or rake the fire in five furnaces in its power-house.

To obtain foundation for an economizer the company had dug four holes, about 6 feet square and 10 or 12 feet in depth. One of these holes was near one of the furnaces Frye was engaged in "slicing," and it was necessary for him to face the furnace and step backward to enable him to slice the fire to the front. As he stepped back, he fell into the hole and was seriously injured. Frye brought suit against his employers to recover damages

for his injuries thus received, and was awarded a verdict of $4,166 in the Supreme Court of Maine.

The defendant moved for a new trial, upon the ground that the verdict was against the law and evidence, but was unsuccessful.

The defendant endeavored to avoid all responsibility for the accident by contending that the plaintiff assumed the risks of his employment, and that this accident was such a risk. The court refused to recognize the application of this doctrine. Mr. Justice Strout, in writing the opinion of the court, said, "Here plaintiff assumed the risk from the operation of the works under his contract of employment, but not the risk from defects in the plant itself, which defendants were bound to make and keep reasonably safe." (46 Att. R. 804.)

The French Market for Measuring Tools.

A New York firm recently made inquiry through consular channels as to the market in France for measuring tools, such as are used by machinists. The reply by Consul A. M. Thackara, of Havre, has been printed in an advance sheet of consular reports, and is as follows:

"The market in France for the sale of steel rules, caliper gages and graduated scales is an open one—that is to say, it is not controlled or regulated by any particular house or syndicate. There is, in my opinion, a good opportunity for the introduction into France of this class of American-made tools; and the Americans, with their extensive and practical knowledge and the improved methods they use in manufacturing their goods, should be able to command the lion's share of the trade. The only competitors worthy of notice are the Germans, who, by their geographical position, their imitation of American patterns, and their ready adaptation to French requirements, have gained an important position in the French tool market. Americans, however—with their much greater mechanical ability, not to mention their up-to-date machinery and the cheapness of raw material in the United States—if they would show an equal readiness to comply with foreign requirements, would have very little difficulty in outdistancing their German rivals. Of course the scales must, in every case, be metrical, as no other system of measurement is used in France. In this respect, at least, the French lead the way; and it is to be hoped that America will not be long in following suit, as no one can dispute the fact that the metric system excels all others in simplicity and practical usefulness. Its general adoption by all countries is to be greatly desired by those who wish to foster and extend the commercial and industrial intercourse between the various nations. I am informed by the customs authorities of Havre that gages, calipers, etc., are classed under the head of scientific instruments, upon which there is no duty when imported direct from the country of origin. If imported from America into France *via* one of the European countries, there is a surtax of 3.60 francs (69.5 cents) per 100 kilograms (220.46 pounds). . . . If our manufacturers want to open up a foreign trade, they should send abroad intelligent representatives (those speaking the language of the country would have more chance of getting satisfactory results) to investigate the economic and industrial conditions of the market, with a view of either establishing agencies managed and run by their own people (which is by far the best) or of selecting local agents whose financial condition and moral character have been ascertained to be good."

Personal.

A. E. Kenney, formerly with the Ingersoll-Sergeant Drill Company has started out for himself in the business of compressed air installations at 39 Cortlandt street, New York.

S. A. Worcester, for the past three years special machine designer for the Warder, Bushnell & Glessner Company, Springfield, Ohio, has accepted the position of mechanical engineer and superintendent with the Foos Gas Engine Company, of the same place.

Obituary.

D. Joseph Shelly died in New York September 11, fifty-three years old. Mr. Shelly, who was a native New Yorker, was well known in the local railroad and machinist-supply trade, having been for twenty-five years a salesman for H. A. Rogers, of 19 John street. A widow and seven children survive him.

Commercial Review.

NEW YORK, Saturday, Sept. 15.

THE MACHINERY MARKET.

For machine tools, steam engines and electrical machinery, in other words for machinery in general, demand remains in the same sluggish state which has characterized it for many weeks past, but which, it may be reaffirmed, is a state only to be regarded as quiet when compared with the extreme activity that has molded business judgments since 1898. Not only is the volume of contracts actually closed comparatively small, but the diminution extends to inquiry as well, although there seems to be a fair amount of business in the wind, at least in an inchoate condition.

In July and August people sat down to rest. Theirs was not the enforced idleness of business despondency, but rather the attitude of men who have worked so hard that they are tired out. Vacations were indulged in perhaps more liberally than ever before, and Saturday holidays seem to have been more general. Why the month of September has set in to be a repetition of July and August is partly to be explained on two grounds—the election, and consumers' hope of lower prices if they wait. The former certainly has some effect. Parties who propose to buy machine tools are known in actual cases to be delaying their purchases until after the election to see what the outcome will be. Political interests are believed to hinder the engine trade somewhat, since engineering schemes, the furtherance of which is dependent upon interviews with capitalists and other men of affairs, have to wait while these are off campaigning. But as regards machine tools the price occasion for delay is probably far more important than the political one. Upon foreign trade the latter can, of course, have no direct influence.

Declines in prices of engines that have taken place earlier or later are to be called quite prevalent throughout the market. There have been some cuts which were merely allowances for lower cost of material and it would seem that there have been further competitive cuts as well. An official of one of the strongest engine building companies states plainly that his concern has reduced prices about 10 per cent., and that in his opinion this is the average drop in the market. Prices, he considers to be now on a satisfactory basis, it being one that corresponds to normal prices of material. Before the advance on billets they were selling at about $20 per ton; they went up to $60 and have reacted to $30 where, it is judged they may with propriety remain. Likewise a pig iron which went up from $10 to $23 has fallen back to $14.50; $12 to $15 being pronounced normal prices. We have made inquiry of other engine companies, which assert that they have kept enough work on hand to avert the necessity of making any concessions in their prices; and the inference may be drawn that a maintenance of former values is somewhat less exceptional than the earlier statement would indicate.

It is an unusual thing for the British Government to allow the purchase by its departments of supplies made in other countries, and few foreign concerns have, heretofore, been favored with orders of this character. An exception has recently been made in the case of a large contract placed with the Nicholson File Company, of Providence, R. I. Knowing that the War Office of Her Majesty's Government was much pressed for the prompt delivery of supplies for the South African War, the Nicholson Company, acting through its London office, placed its Great Britain stock at the disposal of the Government. A most appreciative acknowledgment was immediately received, and shortly afterwards, after a comparative test of the Nicholson files and rasps a large order was placed with the Nicholson Company by the War Office for immediate execution.

The Grant Machine Tool Works and the Grant Ball Company are to be moved from Cleveland, O., to Franklin, Pa. Their proprietors and others have formed a new company with a capital stock of $600,000, of which $300,000 is common and $300,000 preferred. Five acres of land have been obtained at Franklin, which will afford room to grow over for a short time at least and buildings are to be erected immediately. The main building will be a machine shop, 250x100 feet, with a thirty ton power traveling crane, a 300 horse-power Brown engine, all power transmitting machinery furnished by Geo. V. Cresson Company, boilers not yet decided on. The company will put up a building for the ball and screw department, one story, saw tooth roof, dimensions not yet settled, but which will be quite large with room for expansion. The boiler and power house and smith shop will be housed under one roof, but with separate brick partitions going through the roof. The pattern shop, pattern storage, and other departments will be in a separate building. The office will contain all modern appliances.

The directors of the new company are as follows: General Chas. Miller, president Galena Oil Company; R. H. Grant, president Grant Ball Company, J. S. Coffin, general manager Galena Expert Department; J. J. Grant, Grant Machine Tool Works; W. J. Blakely, president International Bank; Samuel Plummer, president First National Bank; J. W. Roland, president Emelton National Bank; A. R. Davis, secretary and treasurer; Harry Lamberton, president Lamberton National Bank. The officers are as follows: General Chas. Miller, president; J. J. Grant, vice-president and general manager; O. D. Blakely, treasurer; A. R. Davis, secretary; R. H. Grant, manager of ball and screw department; Julius Kraus, general superintendent.

The Baldwin Locomotive Works have received an order for twenty-two heavy freight locomotives from New Zealand. They are for use on the Government railroads there. Another order on which work has just been begun is that for six locomotives for the Rio Tinto Mining Company, of Spain. This is a British corporation which is engaged in mining ore. The locomotives ordered are to be of the heaviest kind made at the Baldwins'. During the past two weeks the firm has shipped to Belgium six locomotives for the Belgian State Railway. Six more are ready to be shipped. The first American made locomotives to be used in Ireland were shipped about two weeks ago. They are two engines of the English type, which are intended for use on the Bordon and South Coast Railway. The Kansas City Southern Railroad, formerly known as the Kansas City & Gulf Railroad, has recently ordered ten compound freight locomotives, work on which will begin at once.

Bids for some large engines for waterworks at Detroit, Mich., were received September 11, as follows: Item 1, one engine; 2, two engines. Kilby Manufacturing Company, Cleveland, O., item 1, $148,750; 2, $295,500. Camden Iron Works, Camden, N. J., 1, $139,000; 2, $270,000. Dickson Manufacturing Company, Scranton, Pa., 1, $137,000; 2, $261,400. E. P. Allis Company, Milwaukee, Wis., 1, $140,000; 2, $276,000. Detroit Shipbuilding Company, Detroit, Mich., 1, $173,000; 2, $340,000. Holly Manufacturing Company, Lockport, N. Y., 1, $149,900; 2, $294,800.

The Aultman Company, Canton, Ohio, has arranged with the C. T. Patterson Company, Ltd., of New Orleans, to represent it in its complete line of elevating, conveying and power transmitting machinery. A competent engineering force is to be at hand, to attend to all inquiries for this class of apparatus.

The Bullock Electric Manufacturing Company which still has a great deal of work ahead, although new orders are not coming in so fast as they were, has received among its recent orders the following: Lister's Agricultural Chemical Works, two 200-kilowatt generators and 17 motors of 90 horse-power and under; Wier Frog Company, of Cincinnati, manufacturers of special track equipment, which is electrically equipping its shop, an additional motor order, the fifth or sixth re-received from it.

It is noted by a concern which comprises an engineering as well as an engine sales department that the former is very busy with new work while the latter is rather quiet. Explanation for this is sought in the growing tendency to "lump" contracts.

CHICAGO MACHINERY MARKET.

Specifications of new work for electrical power are more numerous than during the summer, but the prospective buyers are slower to close. The season for fall installation has passed and besides, according to the view of many electrical men, the presidental campaign is exerting its influence, now that the orators have warmed up and are demanding a wide hearing for their respective causes. It is common to hear of a transaction that is to go through "if the election goes right," with pretty clear intimations that negotiations will be called off if the results of the election are not "all right." The large amount of figuring that is going on involves many manufacturing plants, but includes also all kinds of electrical work. There are many electrical railways projected, and the number of lighting plants partially provided for is legion, but transformations of power in the shop and factory, both actual and prospective, are numerous.

One or two large sellers of electrical equipment describe the market as quiet, mainly for the reason noted above, but in spite of that consideration the usual comment on the state of trade is that it is satisfactory. And the faith which the trade seems to have in the future is child-like in its strength and sincerity, supported as it is by the logical conclusions drawn from present conditions. There is therefore very little of a discouraging nature to be encountered. The various makers and their representatives are both zealous and confident in the prosecution of their duties and they succeed in stirring up much business.

A large agricultural implement manufacturer, who has just removed his plant from one city in Illinois to another, has given an order for a complete electrical equipment to a Western maker. The Otis Elevator Company, of Chicago, is equipping its new factory with electrical power and has given the contract for three generators of 75 kilowatts each to the Sprague Electric Company.

The packing interests are among the most active buyers. The Armour Packing Company, of Kansas City, has just bought from the Eddy Electric Manufacturing Company, a large number of motors, aggregating about 600 horse-power, to be added to its plant in that city, already equipped with generators of large capacity. The Booth Packing Company is in the market for four generators of 75 kilowatts each.

Quotations.

NEW YORK, Monday, Sept. 17, 1900.

Iron—American Pig, tidewater delivery:—

Pennsylvania Irons:

No. I X foundry	$16 00 @ $16 50
No. 2 X foundry	15 25 @ 16 00
No. 2 plain	14 75 @ 15 50

Alabama Irons:

No. 1 foundry, or soft	16 25 @ 16 50
No. 2 foundry, or soft	15 25 @ 15 50
No. 3 foundry	14 75 @ 15 00
Foundry forge	14 00 @ 14 25

Bar Iron—Base sizes—The price is about 1.40c. for refined brands on dock, and 1.65 @ 1.85c. for same from store.

Tool Steel—Base sizes—Good standard quality, 7 @ 8c.; extra grades, 10 @ 14c.; special grades, 16c. and upward.

Machinery Steel—Base sizes—From store, 1.60 @ 1.70c. It is claimed that some has been offered for 1.50c.

Cold Rolled Steel Shafting—Base sizes—From store, 2½ @ 3.00c.

Copper—Lake Superior ingot, in carloads, 16⅞ @ 17c.; electrolytic and casting, 16⅝ @ 16¾c.

Pig Tin—29.75 @ 29.85c. for 5 and 10-ton lots, f. o. b.

Lead—For wholesale lots, 4⅜ c., with .02½ @ .05c. extra for carloads, New York.

Spelter—Prime Western, 4.05 @ 4.15c. New York delivery.

Antimony—Cookson's 10½ @ 10¾c.; Hallett's, 9¼c.; United States, 9.20 @ 9⅜c.

Lard Oil—Prime city in barrel lots, 55 @ 57c.

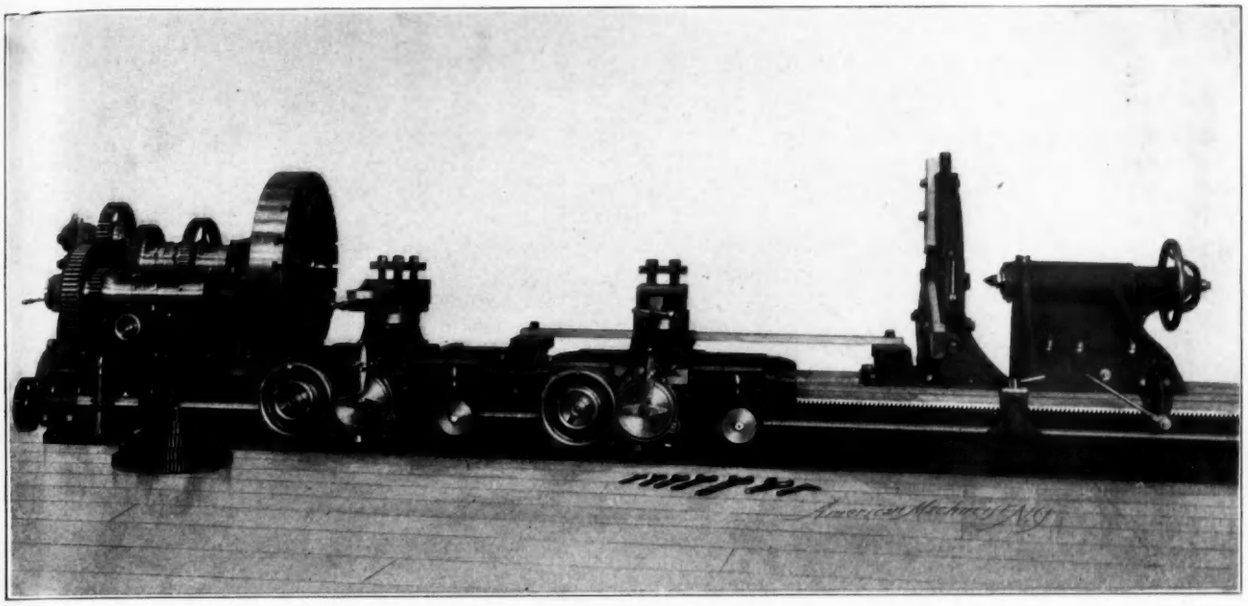


FIG. 1. FRONT VIEW OF 52-INCH ELECTRICALLY DRIVEN GUN LATHE.

Electrically Driven Gun Lathe.

The accompanying illustrations show a 52-inch lathe for gun work, of which several have been supplied by Bement, Miles & Co. to American and English gun makers. The incorporation of an electric motor as part of the lathe has led to some interesting features. The motor, which was supplied by the Westinghouse Electric & Manufacturing Company, is of the variable-speed type, although the motor alone is not depended upon to accomplish all of the variations in speed. Combination back gearing with suitable clutches will be seen to be introduced on and about the live spindle in place of the usual cone pulley, which, in connection with the variable-speed motor, gives the same number of speeds as the usual cone pulley and back gears.

The two tool posts have power feeds for longitudinal, facing and angular cuts, three changes being provided which are controlled by the hand-wheel in front of the live head connected with suitable clutches and cone gearing inside. The carriages have also a quick power traverse obtained through the belt pulleys seen in Fig. 2 and the sprocket wheels and pitch chain extending through the bed. The taper attachment is mounted in an unusual manner, being clamped to the V's over the center of the shears. The centers are set back from the center line of the bed, in accordance with the usual Bement practice with large lathes—the object of the arrangement being to prevent the overhang of the tool-post in front when turning large diameters.

The capacity of the lathe is such as to fit it for machining 8-inch guns.

At Cannstatt, in Würtemberg, are constructed automobile motors of 32 horse-power weighing not more than 300 pounds, about 9 pounds to the horse-power.

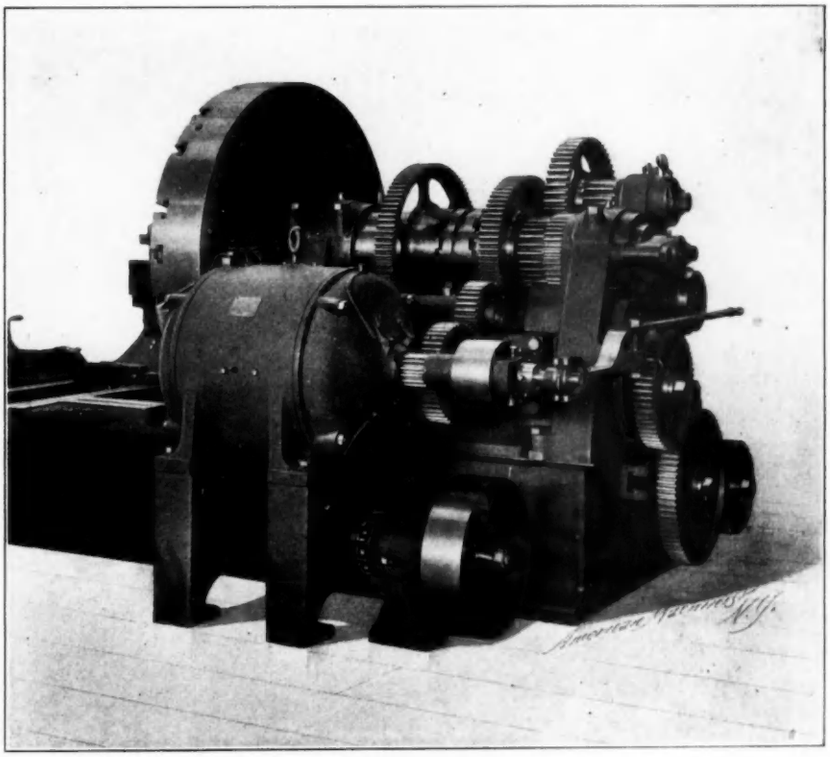


FIG. 2. REAR VIEW OF LATHE HEAD, SHOWING CONNECTION WITH MOTOR.

Equal Mid-Gear Lead in Locomotives.

We are in receipt of a letter from Mr. J. I. Brewer, of Terre Haute, Ind., pointing out an error in the proof given in Mr. Halsey's "Locomotive Link Motion" of the fact that in order to obtain equal mid-gear leads, the link radius must equal the length of the eccentric rods measured to the link arc.

It has, we believe, been universally held that the link radius should be thus obtained, and Mr. Brewer is entitled to the credit of discovering an error which, however, cannot be considered as a large one, as the figures below will show.

Mr. Brewer shows that the link radius should, in fact, be shorter than the eccentric rods. In three cases which he has calculated, the difference between these two distances is as follows:

With 40-inch eccentric rods, .2121 inch,
With 60-inch eccentric rods, .1576 inch,
With 80-inch eccentric rods, .1000 inch.

Making the radius of the link equal to

the length of the rods, Mr. Brewer obtains the following values for the forward and backward mid-gear leads, instead of the equality which is supposed to exist:

	Forward lead inch.	Backward lead inch.
With 40-inch eccentric rods.	.3591	.3638
With 60-inch eccentric rods.	.2384	.2399
With 80-inch eccentric rods.	.1788	.1792

Mr. Brewer's demonstration is quite long and involved, and we give the essential facts developed in lieu of it.

Geometrical Construction of the Logarithmic Scale.

BY ROBERT A. BRUCE.

Recently a good deal of attention has been directed in the columns of the "American Machinist" to the uses and advantages of the logarithmic scale, and it has been pointed out that the scale itself can be copied from an ordinary slide rule or one of the many logarithmic diagrams which have from time to time appeared. There are many, however, who think that a certain standard of mathematical knowledge is essential for the proper understanding of such scales, and it is incontrovertible that a grasp of the underlying principles of logarithms is necessary for an intelligent appreciation of their real value and extended application. The following article is an attempt to furnish a clear explanation of such principles without assuming anything beyond the elementary knowledge which is in the possession of every reader.

If the number 1 be multiplied by any other repeatedly, we shall obtain at each operation a fresh number, and these may be arranged in order of magnitude so as to form what is known as a geometric progression. Thus 1, 1×2, $1 \times 2 \times 2$, $1 \times 2 \times 2 \times 2$—or 1, 2, 4, 8, 16—is such a series; or again, 1, 1×3, $1 \times 3 \times 3$—or 1, 3, 9, 27, 81—is another. If the multiplying factor (2 in the first and 3 in the second case) is called the "base," each "term" of the series is seen to contain the base a certain number of times. The number of times which the base is used as a multiplier in forming any one number of such a series is known as the "logarithm" of the number to the given base. Thus in the fifth term of the first series, the base 2 is used as a multiplier 4 times, hence the logarithm of 16, to the base 2, is 4. This fact being often written: $\log._2 16 = 4$. Similarly $\log._3 27 = 3$ (since $27 = 1 \times 3 \times 3 \times 3$).

A few numbers and their logarithms are given in the table, an examination of which will easily convince the reader of the truth of the following statements: If two or more numbers are factors of another in the same column, the sum of the logarithms of the factors is equal to the logarithm of the product. For example: From the table we see that $\log._2 32 = 5$, $\log._2 8 = 3$, $\log._2 4 = 2$. Now $32 = 8 \times 4$ and $5 = 3 + 2$. Again, $\log._2 1.024 = 10$, and $1,024 = 32 \times 8 \times 4$, while $10 = 5 + 3 + 2$. Again, $6,521 = 243 \times 27$, and, taking logarithms, $8 = 5 + 3$. As a necessary consequence: If any number, when divided by another in the same column, gives a quotient also in the same column, the logarithm of the quotient is equal to the difference between the logarithms of the numbers. For example: $\frac{4,096}{512} = 8$, the logarithmic relationship being $12 - 9 = 3$. Again $\frac{59,049}{729} = 81$, the logarithmic relationship being $10 - 6 = 4$. If any number when squared or cubed gives another in the same table, the logarithm of the square is twice, and of the cube is three times that of the number. For example: $19,683 = 27 \times 27 \times 27 = 27^3$, and $\log._3 19,683 = 9 = 3 \times 3$, and 3 is $\log._3 27$. As a necessary consequence, if the square or cube root of any number is found in the same column, the logarithm of the square root is half and of the cube root is one-third of the logarithm of the original number. For example: $\sqrt[3]{4,096} = 16$, and $\log. 16 = 4$, and $\log. 4,096 = 12 = 3 \times 4$. These facts, curious though they may appear, would at first sight seem to be of limited utility. Were the power of forming such series as those given in table 1 unlimited, however, it would appear that multiplication and division could be dispensed with in favor of addition and subtraction, and involution and evolution in favor of multiplication and division. Methods have been developed by mathematicians of expressing any number as a power of any other, with the result that comprehensive tables of numbers and logarithms have been published.

For the majority of calculations in engineering which depend upon physical data of only approximate accuracy, it is misleading to express numerical results with great accuracy. For instance, it is absurd and misleading to say that the horse-power of an engine is 123.61, these figures having been derived from an indicator diagram whose probable accuracy is not within 1 per cent. of the truth. The statement of the result to two places of decimals would seem to imply that we are able to find the power of the engine within a limit of .01 of a horse-power, whereas we are unable to say more than that the horse-power lies somewhere between 123 and 124. Where an accuracy of one-tenth of 1 per cent. is sufficient, it has been found possible to combine in the slide rule an instrument which is virtually a table of logarithms and a means of mechanically adding or subtracting them. The properties of the slide rule depend upon the power of constructing a logarithmic scale, which in brief by its graduations gives a series of lengths which on the selected scale are equal to the logarithms of the numbers with which they are figured. Thus from the table an elementary logarithmic scale could be constructed, as follows: In Fig. 1 take a line equally divided into twelve parts, each of which represents one unit. Figure the left-hand extremity 1, and going from left to right figure the graduations 2, 4, 8, 16, etc., as in the first column of the table. Each number is then represented by a graduation the distance of which from the left-hand extremity of the scale is equal to as many units as gives the

Numbers and Logarithms to Base 2.			Numbers and Logarithms to Base 3.		
No.	Log.	Formation of Number from Base.	No.	Log.	Formation of Number from Base.
1	0	1. . . . .(base not used)	1	0	1. . . . .(base not used)
2	1	1×2 . . . . . (1 factor)	3	1	1×3 . . . . . (1 factor)
4	2	$1 \times 2 \times 2$ . . . (2 factors)	9	2	$1 \times 3 \times 3$ . . . (2 factors)
8	3	$1 \times 2 \times 2$ . . . (to 3 factors)	27	3	$1 \times 3 \times 3$ . . . (to 3 factors)
16	4	$1 \times 2 \times 2$ . . . (to 4 factors)	81	4	$1 \times 3 \times 3$ . . . (to 4 factors)
32	5	$1 \times 2 \times 2$ . . . (to 5 factors)	243	5	$1 \times 3 \times 3$ . . . (to 5 factors)
64	6	$1 \times 2 \times 2$ . . . (to 6 factors)	729	6	$1 \times 3 \times 3$ . . . (to 6 factors)
128	7	$1 \times 2 \times 2$ . . . (to 7 factors)	2187	7	$1 \times 3 \times 3$ . . . (to 7 factors)
256	8	$1 \times 2 \times 2$ . . . (to 8 factors)	6561	8	$1 \times 3 \times 3$ . . . (to 8 factors)
512	9	$1 \times 2 \times 2$ . . . (to 9 factors)	19683	9	$1 \times 3 \times 3$ . . . (to 9 factors)
1024	10	$1 \times 2 \times 2$ . . . (to 10 factors)	59049	10	$1 \times 3 \times 3$ . . . (to 10 factors)
2048	11	$1 \times 2 \times 2$ . . . (to 11 factors)	171147	11	$1 \times 3 \times 3$ . . . (to 11 factors)
4096	12	$1 \times 2 \times 2$ . . . (to 12 factors)	531441	12	$1 \times 3 \times 3$ . . . (to 12 factors)

TABLE OF LOGARITHMS TO BASES 2 AND 3.

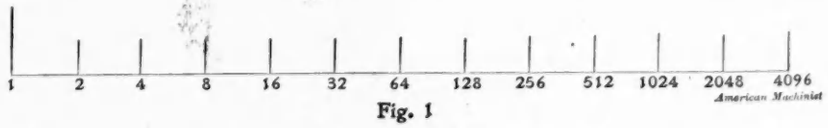


Fig. 1

ELEMENTARY LOGARITHMIC SCALE TO BASE 2.

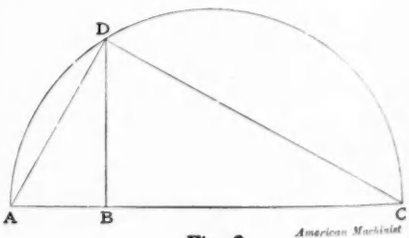


Fig. 2

FINDING THE GEOMETRIC MEAN.

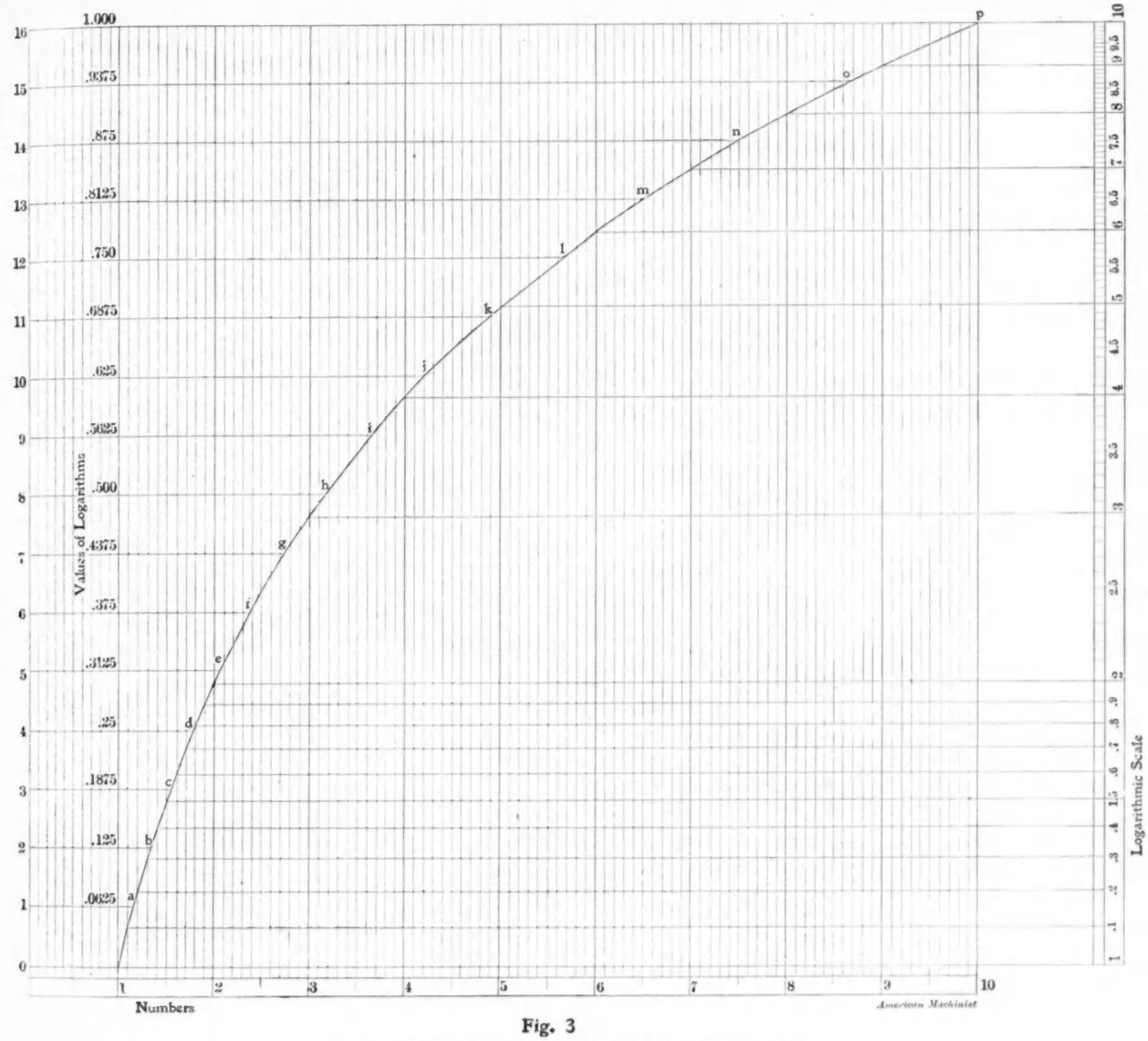


Fig. 3

GEOMETRICAL CONSTRUCTION OF A LOGARITHMIC SCALE.

logarithm of the number considered. In other words, the numbers are represented not by their own scale lengths, but by those of their logarithms, with the result that the addition of the scale lengths of two numbers gives a new scale length equal to that of the product of the numbers. Thus the scale length representing 64 is equal to the sum of the scale lengths of 32 and 2, or of 4 and 16, or to the difference between the scale lengths of 256 and 4, or of 512 and 8.

The deficiency of such a scale is due to its lack of sufficient subdivisions, consequently it is necessary to see how this defect can be remedied. If any three consecutive numbers and their logarithms be selected, it will be seen from the table that while the middle logarithm is the half of the sum of the other two, the corresponding number is the square root of the product of the other two numbers. Thus selecting the numbers 16, 32, 64, we find that $32 = \sqrt{16 \times 64}$, and taking the corresponding logarithms 4, 5, 6, we find that $5 = \frac{4 + 6}{2}$. Thus, given two numbers and two logarithms, we can insert an intermediate number and its corresponding logarithm, and then in turn other "means," the law to be observed being that the number is the geometric mean of the numbers between which it is inserted and the logarithm is the arithmetic mean of the logarithms between which it is inserted. If numbers and logarithms be each represented by lines to scale, the arithmetic mean is half the sum of the two lines. The geometric mean can be obtained by construction, as follows: Referring to Fig. 2, let any two numbers be represented by scale lengths AB, BC, placed so as to form a continuous line AC. Construct a semicircle on AC and through B draw a perpendicular BD to cut it at D. The length BD then represents the geometric mean of AB and BC, and is the scale length representing the intermediate number. Proof: Join DA and DC, then we have two similar right-angled triangles ABD and BDC. Hence $\frac{AB}{BD} = \frac{BD}{BC}$ or $BD = \sqrt{AB \times BC}$.

In constructing logarithmic tables or scales, the base 10 is usually chosen, and from what we have seen, the first two numbers are 1 and 10 and the first two logarithms are 0 and 1. That is, $\log_{10} 1 = 0$ and $\log_{10} 10 = 1$. To construct a logarithmic scale with decimal subdivisions between 1 and 10 we should proceed as follows: A base line is chosen, as in Fig. 3, and divided into ten equal parts, each one unit in length, and this is numbered from 0 to 10 and is a scale of numbers. Each division of one unit is again decimally subdivided. A line 0—16 is next drawn at right angles to the base line and of a length equal to that of the proposed scale, and therefore of unit length on the scale of logarithms. The length 0—16 is bisected at 8 and the two segments are again bisected at 4 and 12, and so on till we have in all sixteen subdivisions. These correspond to the subdivisions of the scale

value of log. 10. To find the number corresponding to logarithm represented by 0—8 we must find the geometric mean of 1 and 10.

This is done in Fig. 4, where $S\,k'$ is made equal to 1 unit on the scale of numbers, and $S\,t'$ equal to 10 such units; $t'\,k'$ is then bisected at 8c, and a semicircle on this line as diameter is then drawn, cutting the perpendicular through S at 8. The length $S8$ is the scale value of the number

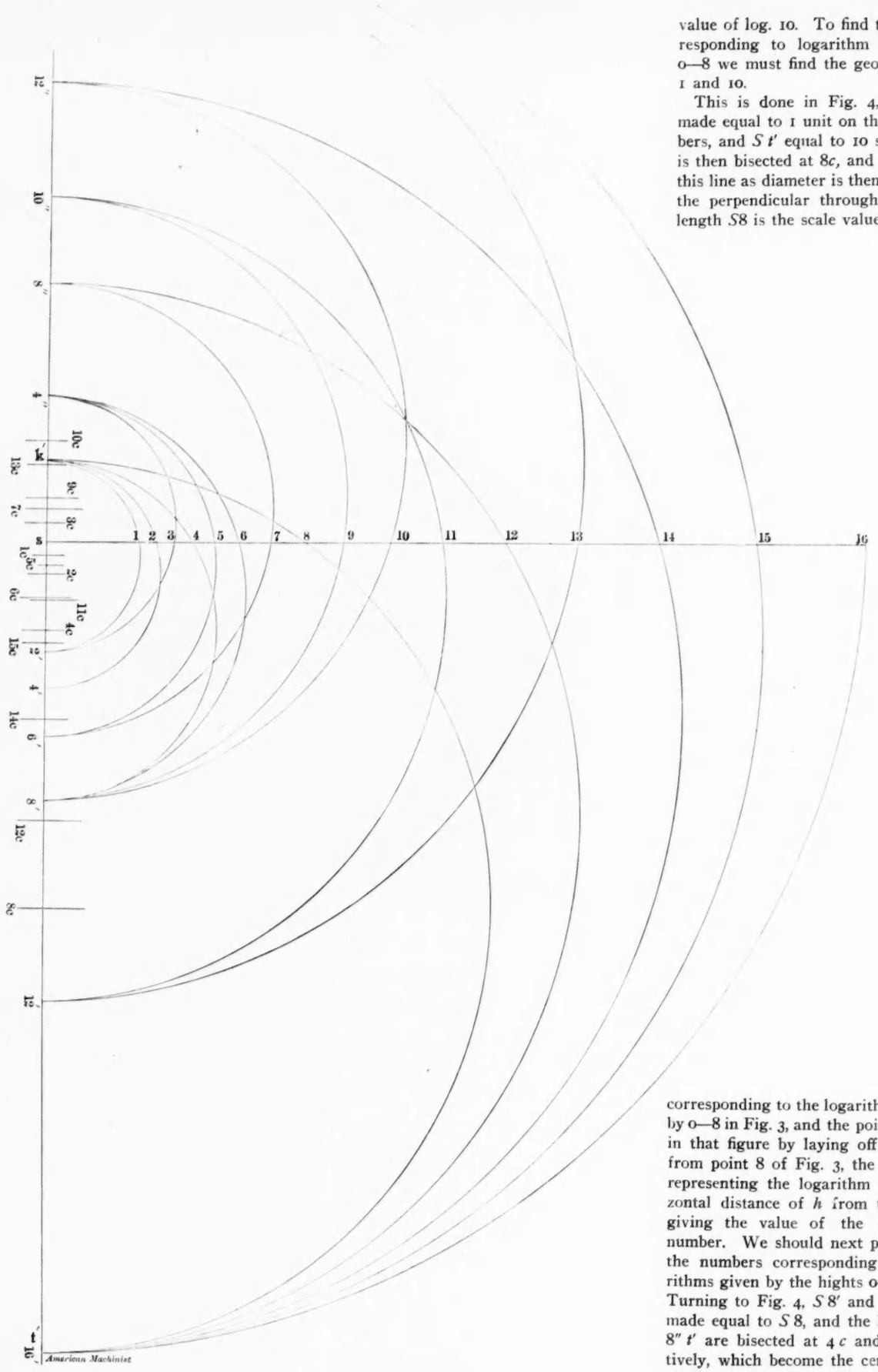


Fig. 4
CONSTRUCTING THE CURVE OF FIG. 3.

corresponding to the logarithm represented by 0—8 in Fig. 3, and the point h is located in that figure by laying off $S8$ of Fig. 4 from point 8 of Fig. 3, the ordinate of h representing the logarithm and the horizontal distance of h from the line 0—16 giving the value of the corresponding number. We should next proceed to find the numbers corresponding to the logarithms given by the hights 0—4 and 0—12. Turning to Fig. 4, $S\,8'$ and $S\,8''$ are each made equal to $S\,8$, and the lines $8'\,k'$ and $8''\,t'$ are bisected at 4 c and 12 c, respectively, which become the centers of semicircles about $8'\,k'$ and $8''\,t'$ as diameters. The semicircles cut the perpendicular $S\,16$ at 4 and 12, and $S\,4$ and $S\,12$ are the

values of two more intermediate numbers, and serve to locate the points *d* and *l* in Fig. 3. In precisely the same manner the remaining points *a, b, c, e, f, g, i, j, k, m, n, o* are found, and the points are sufficiently near for us to now construct with fair accuracy the curve shown. The hight of any point gives the value of the logarithm and the distance to the right of 0—16 gives the corresponding number. In order, therefore, to construct the scale at the right of Fig. 3, we have only to project a series of horizontals from the points, where the vertical ordinates through the decimal subdivisions of the scale of numbers cut the curve. These will give directly the subdivisions of the logarithmic scale. One point of great importance in connection with such scales is, that there is an equal percentage of accuracy at any part of the scale. Thus it is obvious that as any number such as 16 is equal to 10×1.6, the point 16 will be found one unit above 1.6; similarly, since $17 = 10 \times 1.7$, 17 will be found one unit on the logarithmic scale higher than 1.7. Hence the difference on the scale between 17 and 16 is the same as the difference between 1.7 and 1.6. Suppose that we can estimate the scale to one-tenth of such a space, the error in the one case is $\frac{17-16}{10}$, and in the other $\frac{1.7-1.6}{10}$, or .1 in the first and .01 in the second; but as the quantity measured in the second case is one-tenth of the first, the percentage of error in the reading is the same.

New Brompton, England.

A New Hack-Saw Machine.

The illustration presented herewith represents an improved form of the now well-known hack-saw machine, in which a positive feed has been substituted for the gravity feed; in which the saw is given a vertical instead of a horizontal movement and the movement is uniform throughout the cutting stroke, with quick return. The machine is driven by a belt wheel which has a cam on its side, as shown, this cam imparting motion to the saw frame. At the top of the stroke a ratchet wheel at the end of the feed-screw engages with pawl and the feed-screw is thus slightly turned at the beginning of the next downward stroke. There is a half nut for engaging the feed-screw, so that it can be readily opened and the saw run back. The upper end of the saw can be set slightly in advance of the lower end, so that the upward stroke relieves the saw from pressure on the work. Both the motion for the stroke of the saw and that for the feed take place in planed and gibbed guides. The feed is adjustable and can be changed while the saw is in motion, if desired, by turning the screw seen at the top. The machine is made by Wright & Colton Wire Cloth Company, Worcester, Mass.

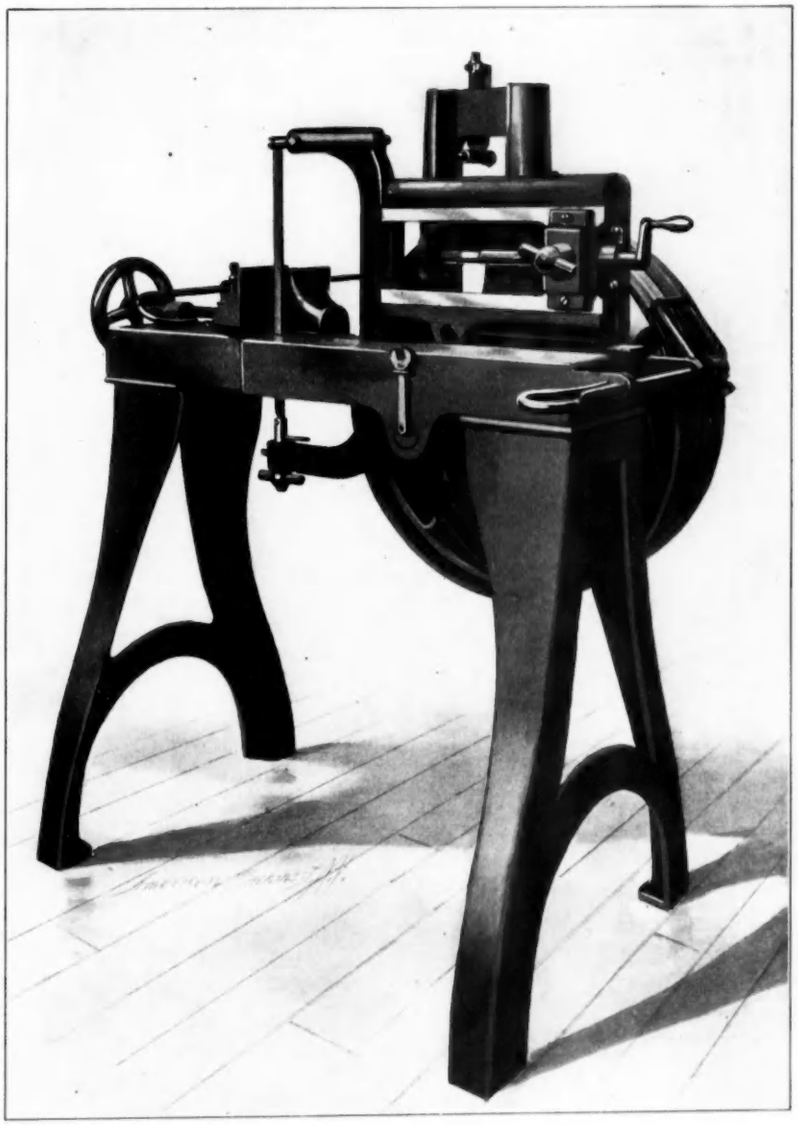
Designing Spiral Gears by the Quadrant Method.

BY W. H. CROKER.

The fact of the appearance of a very interesting article on this subject by Mr. Bruce with some editorial remarks thereon, which were contained in the "American Machinist," No. 15, has led me to offer another method on similar lines, which, I think, may present some features of interest and improvement beyond what has thus far been written on the subject, the aim being to eliminate the most of the tentative preliminaries that are usually involved in the schemes I have examined. I am a strong advocate of the graphical method, believing it will be found to answer every requirement in practice. I have no thought of writing learnedly on this matter, desiring rather to present the results of my investigation in a plain, shop-talk manner.

My preference is to deal with a quadrant of the gear as a fundamental basis instead of considering the whole, as by so doing the drawing is made much more compact and handier to manipulate, and quite as intelligible when once the rationale of the process is understood.

I have thought it wise to treat a case covering the same conditions as the initial case in Mr. Bruce's article, in which we had: Axes at right angles; center distance of axes, 5 5 inches; velocity ratio, 2 : 5; cutters for teeth, 8 diametral pitch; desired diameter of pinion, about 4 inches.



A NEW HACK-SAW, CUTTING-OFF MACHINE.

Referring to the diagram, Fig. 1, *A B* is the center distance of axes, 5.5 inches. Make *A F* square to *A B*. Find the development of the quadrant of the proposed pinion, which will be 3.1416 inches, and set this off from *A* to *H*. On *A* as center strike the quadrant *B D C* with axes center distance *A B* as radius. On *C* as center, with same radius, make an intersection on quadrant at *D*, and connect *A D* produced to *E*; draw *B P* parallel to *A F*; make *C F* equal to *B E*; bisect *A F* in *G*

for center, and strike the semicircle $A\,O\,F$. This semicircle is called the "limit curve." Now, the distance $A\,F$ is equal to the development of the quadrant $B\,D\,C$,* as it is also equal to any two quadrant developments whose added radii shall equal $A\,B$; for instance, the development of quadrant $M\,N$ plus that of quadrant $M\,P$ will equal $A\,F$, so that whatever relative size of gears we adopt on the given fixed distance $A\,B$, the dimension $A\,F$ will necessarily be an element (and a ruling one) in our determination of the pair of gears, no matter what their difference of radii may be, if their sum is to equal $A\,B$. The next step is to cut out from a separate piece of suitable paper, or tracing cloth if preferred, the "ratio scale." This is shown by the dotted lines $O\,X\,Y\,O$. The sides $O\,X$ and $X\,Y$ are to be perpendicular, and their lengths to one another as the velocity ratio—in this case 5 to 2—and the length of $O\,X$ somewhat in excess of $A\,E$. Along $O\,X$, starting from O, is laid off a scale with divisions made square across the paper scale from $O\,X$ and of a distance apart equal to the circular pitch involved, in our case .3927 inch. For convenience in use of scale, a small right-angle part Z is left intact with the scale to avoid the acute angle at O. The scale being ready, we place it over Fig. 1 in the position shown by the dotted lines, keeping its zero point O always on the "limit curve" $O\,O'\,F$ as shown, with side $O\,X$ always passing through A. Shift the scale about till the line $O\,Y$ comes fair with H; $A\,H$, as we remember, being the development of the desired pinion quadrant. On tracing across the paper scale by a line $H\,J$, we find that it comes out on $O\,X$ side at about 11.5 divisions circular pitch, which we multiply by 4 and obtain 46, as the number of teeth in the gear; but on testing the return distance $J\,H$ on our scale we get 4.6 circular pitches, which multiplied by 4 gives 18.4 teeth to the pinion, showing that the ratio works out with an impracticable fraction, so that a revision is needed. Trying 11.25 by 4 we get 45 for the gear, and the other term of the ratio gives us on the scale $4.5 \times 4 = 18$, the number of teeth for the pinion. We now shift the scale to the position shown by full lines $O'\,X'\,Y'$, making 11.25 ($O'\,L$) divisions across to point K, bringing K on scale to coincide with line $A\,F$. This final position of the scale gives us the true angle for pinion, as shown at A, and the gear angle as shown at F, while $A\,K$ is the corrected quadrant development of pinion, and $K\,F$ the correct quadrant development of the gear. The quarter spiral advance for the pinion will be $K\,Q$ drawn square to $A\,E$, and the quarter spiral advance of the gear will be $K\,T$, obtained by producing $F\,O'$ to cut $K\,T$ in T. We now

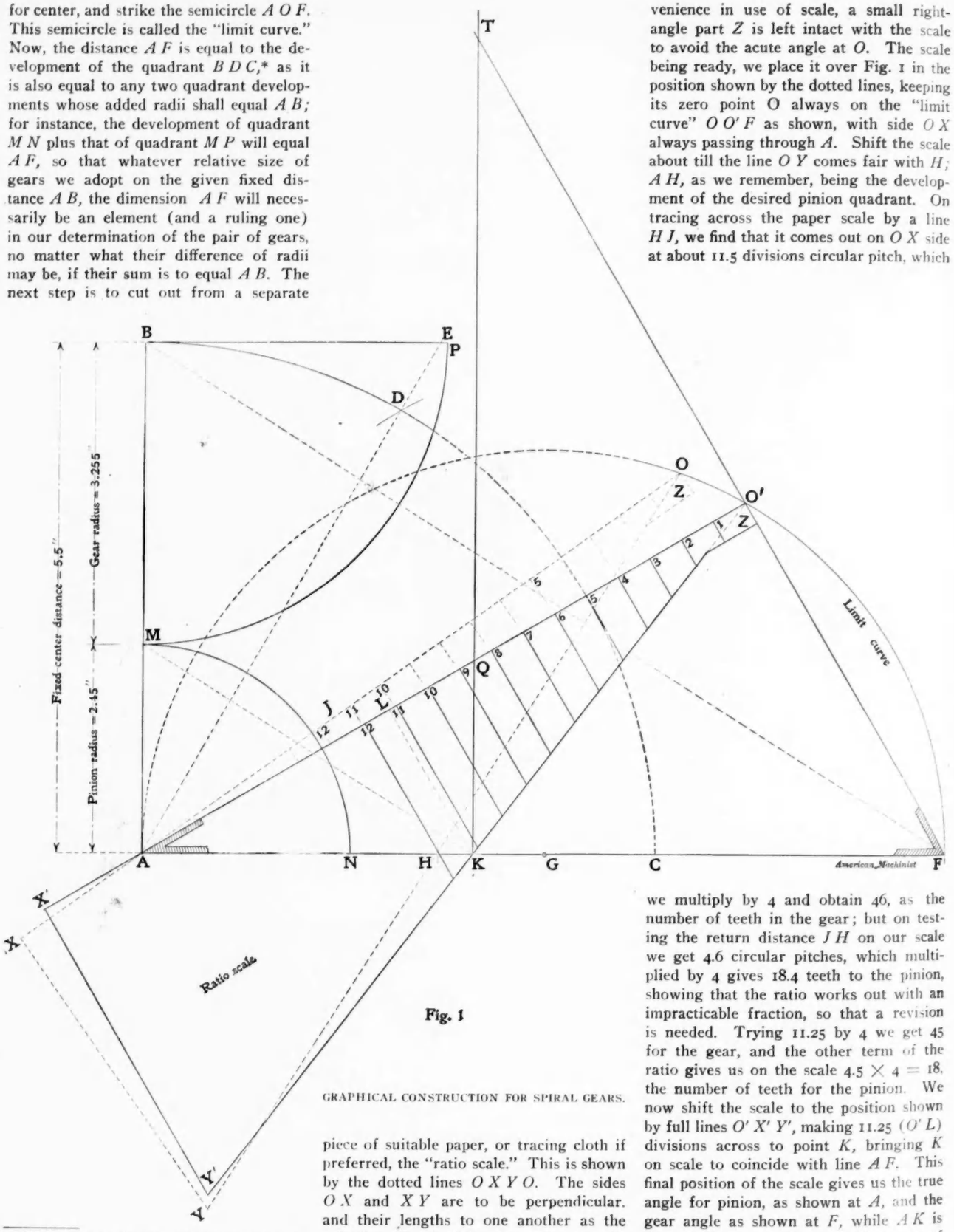


Fig. 1

GRAPHICAL CONSTRUCTION FOR SPIRAL GEARS.

*This construction is, of course, approximate only. For the case shown, it gives for the length $A\,F$ 8.6754 inches, whereas the true development of the quadrant by calculation is 8.6394 inches. The error is .036, or .004 part in one. Mr. Croker does not consider this error vital, though it may be easily avoided by calculating the distance $A\,F$ or by using a special triangle having the base and perpendicular in the ratio of $\frac{\pi}{2}$ to 1.—Ed.

require to know the radius of the pinion, which can be readily obtained graphically by connecting *F B* and drawing *K M* parallel to *F B;* then *A M* is radius of pinion, and *B M* that of the gear. By the term "spiral advance," I mean the pitch of the helix or the travel of the carriage of the milling machine to complete one revolution of the spiral or a point on the work.

We now require to know what equivalent spur gear radius will correspond to the pinion for selecting the cutter by, also for that of the gear. This is obtained by Fig. 2. Draw *A E* at random; set out an octant arc *A B C* with radius of pinion,* and draw *B D* square to *A E*. At *B* put in the gear angle as shown, getting *B E;* square from *B E* the line of radius draw *Y E F* and make *E Y* equal to *D C;* find a center *F*, with radius to strike the arc *Y B*, then this radius multiplied by twice the diametral pitch will give the number of teeth required for a corresponding spur gear. In this case the radius is 7.5 inches, which multiplied by 16 gives 120 teeth, so we select a cutter suited to cut that number of teeth on a spur gear, and use it to cut the pinion that has only 18 teeth. Similarly, draw the octant *A B' C'* with pitch radius of the gear, and draw *B' D'* square to *A E;* draw from *B'* the angle of pinion as shown, getting *B' Z*, and square off *H Z J*, making *Z H* equal to *D' C'* and find center *J* to strike arc *H B'*. This radius is 4.25 inches, which multiplied by 16 (twice the diametral pitch) equals 68, so we want a cutter suited to a spur gear of that number to cut the teeth of gear that has only 45 teeth.

We have now all the data required to construct the gears, remembering to add ⅛ inch to the radius of pinion and of gear, which will give the proper blank radius, as the addendum is not affected by the angle at which the teeth are cut, but remains natural as in a spur gear.

I give another example—that of a pair of spiral gears having equal diameters, but with 1 : 2 velocity ratio, to be cut with 8-diametral pitch cutters, the gears to be kept as small as possible with a view to their compact use on the usual side-shaft in a gas-engine to operate the exhaust valve. The plan is quite popular for that purpose now, being cheap to manufacture and silent in working.

Fig. 3 will illustrate the radial minimum dimensions, where *A* is radius of engine shaft, *B* the dead metal for ring substance, and C the clearance plus dedendum of 8 diametral pitch. The sum of these dimensions is 1.515 inches for the trial pitch radius. This case allows of an extremely simple solution, as there is no fixed center distance, so we can work without the "limit curve," although I have dotted it in at Fig. 4, which will show how to deal with this case. Lay off *A B* and *A E* at right angles; make *A F* equal to the development of the trial radius, as found at Fig. 3. Now take a rectangular piece of paper, as *I H K*, and mark off from zero *H*, along *H I*, a scale of circular pitch parts as shown. Moving *I H* along *A N*, let *H K* first come into agreement with point F, as shown by the dotted line parallel to *H K*. Now consult point *A* and notice its relation with regard to the scale, and we see that in this position there is not the proper scale relation, but moving a small distance toward *N* along *A N* we get the scale to read 5½ divisions, which we multiply by 4, and obtain 22 as the number of teeth for the gear, and as this number is divisible by 2, we get 11 teeth for the pinion. This final position of the scale gives an intersection on *A E* at the point *G*, giving *A G* as the corrected quadrant development for each member—that is, of both gear and pinion. To ob-

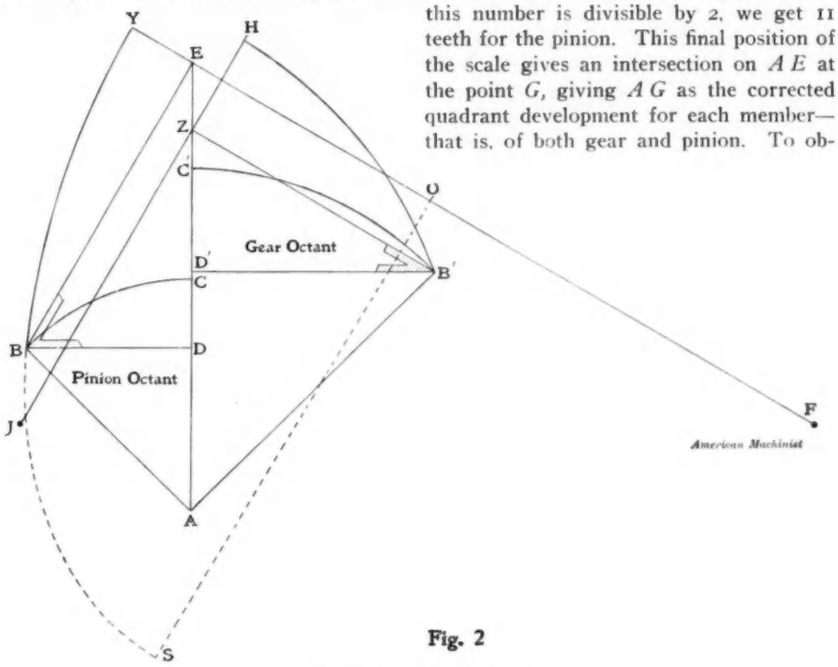


Fig. 2

FINDING THE CUTTERS.

Fig. 3

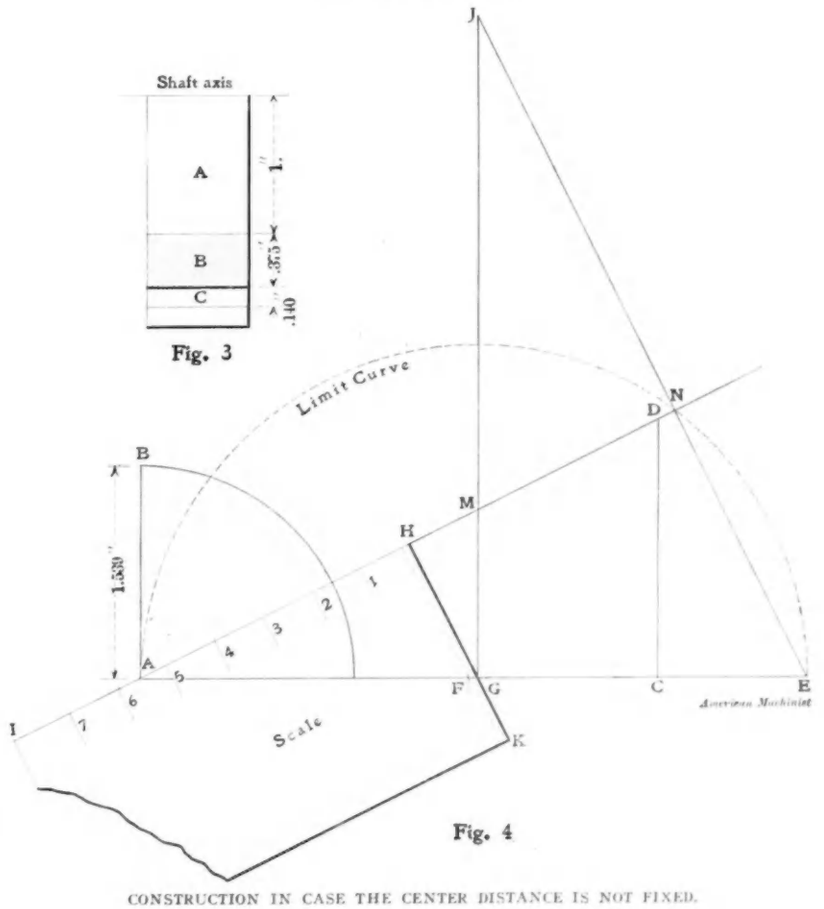


Fig. 4

CONSTRUCTION IN CASE THE CENTER DISTANCE IS NOT FIXED.

*As it is impracticable for the purpose of illustration, to reduce Figs. 1 and 2 from their originals in the same proportion, it will be found that they do not scale. That is, *A M* of Fig. 1 and *A B* of Fig. 2 are not equal to each other, as they were in their originals. The same remark applies to Figs. 4 and 5.—Ed.

tain the radius of the quadrants we may use a constant for such case, which is $A\,G$ multiplied by .6366, and obtain 1,539 inches, the radius for each pitch quadrant. The quarter spiral advance for the pinion will be $G\,M$ square to $A\,E$, and produced to J, $G\,J$ being the quarter spiral advance of the gear, $E\,J$ obtained by making $G\,E$ equal to $A\,G$, with $E\,J$ drawn square to $A\,N$. $A\,N\,E$ is the "limit curve," although it is not required in this example, as the center distance is not a fixed dimension.

The remaining requirement is the proper cutters to use. Fig. 5 explains this. Draw $A\,E$ at random, and an octant on each side thereof to the radius of the pinion or gear, as it is the same in either case. Draw $B\,C$ by $B\,D$ to the angle of the pinion, as shown at B, and obtain $B\,C$. Square $I\,C\,J$ from $B\,C$, and finding center J and radius required, strike the arc $I\,B$, then radius will be about 3.5 inches, which

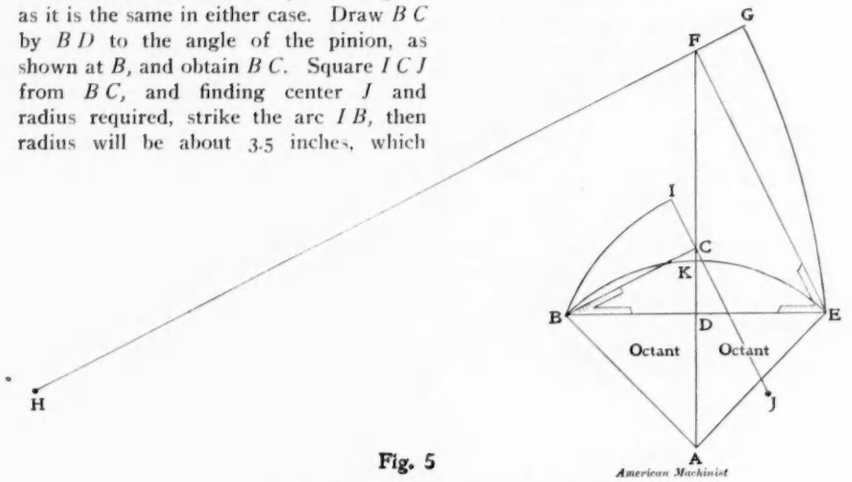


Fig. 5

FINDING THE CUTTERS FOR THE CASE OF FIG. 4.

multiplied by twice the diametral pitch will give 56, so we must cut the gear with a cutter suited to a spur gear of 56 teeth. For the pinion make $E\,F$ to the angle of gear, as shown at E, square $G\,F\,H$ from $F\,E$ and find center at H with radius to strike the arc $G\,E$, then the radius will equal 3.75 inches, giving 60-tooth spur gear, which is the number by which to select the cutter for our pinion. Referring again to Fig. 2 an explanation of the theory of determining the equivalent spur gear radius may be cleared up. If a cylinder of wood be turned to the pitch diameter of the pinion of Fig. 1 and we trace the spiral thereon, and then cut the cylinder through at an angle square to the spiral pitch, we shall obtain a section of cylinder with its resulting ellipse. We know that the diameter of pinion will be the minor axis diameter of the ellipse, and the major axis will be governed in length by the angle at which the cylinder has been cut. Now $O\,Y\,B\,S$ of Fig. 2 is a quadrant ellipse resulting from the section of our supposed cylinder, and $Y\,B$ is an octant of the ellipse. It will be found in all examples of the ellipse that the curve of said octant at the flattest part will closely agree with a circular arc—near enough for the purpose we need it for, which I trust will give the needed explanation of this matter.

I think there will be no difficulty in applying the "quadrant" method of solution to any case of spiral gearing, including axes not at right angles; but should any reader require further details, I shall be pleased to help.

Orillia, Ont., Canada.

[To illustrate the degree of accuracy of his method, Mr. Croker has determined by it the dimensions of a pair of gears which were given in Mr. De Leeuw's article published in our issue No. 2. As Mr. De Leeuw determined the dimensions by calculation, a comparison of his results with those obtained by Mr. Croker shows at once what degree of accuracy may be expected by the latter's method. Following is the comparison:

	De Leeuw by calculation.	Croker by construction.
Center distance (given)	$4\frac{15}{32}$	$4\frac{15}{32}$
Pitch diam. of pinion,	2.971	3.
Pitch diam. of gear,	5.968	5.937
Pitch of spiral gear,	37.334	37.250
Pitch of spiral pinion,	4.6874	4.680
Angle of spiral pinion,	26° 40′	26° 30′
Angle of spiral gear,	63° 20′	63° 10′

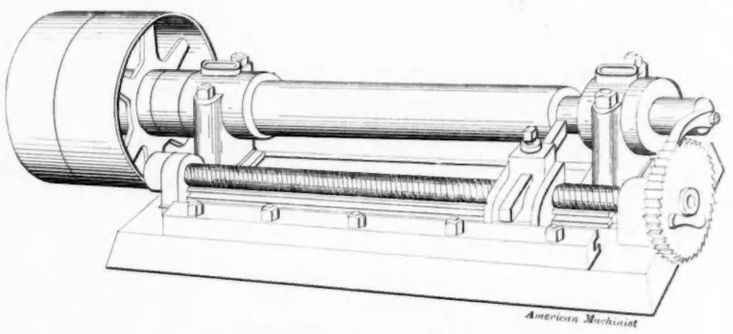
[Mr. Croker also remarks: "Of course you will need something better than an ordinary machinist's steel rule to set out the measurements. I use a special device reading up to 10 inches by thousandths." It will be observed that in finding the proper cutter no refined accuracy is required. In cutting spur gears the same cutter is used in cutting all numbers of teeth between 35 and 54, and similar latitude exists throughout the scale, which fact renders exactness in the determination of the equivalent spur gear unnecessary.—Ed.]

Machine for Making Fine Metallic Shavings.

Three years ago we described how steel wool is made, with an illustration of a machine for the purpose. In that machine, the material from which the fine shavings were cut consisted of circular disks of thin sheet steel, a considerable number of which were concentrically clamped together and rotated at a suitable speed and the shavings were cut from the periphery.

The sketch shown here sufficiently illustrates another machine, recently patented, which seems to be a decided improvement upon that perviously shown. In this machine the material operated upon consists of a single rectangular sheet tightly wound upon a suitable arbor, and the shavings are made by continuously cutting from the end of the roll. There are two evident advantages in this arrangement over that previously described, the first being that the stock needs no preparation and no cutting away of a lot of scrap, as in the periphery of the disks, and that practically all of it can be made into the desired shavings. The other advantage is that the work of cutting goes on from beginning to end at a uniform speed, whereas with the constantly diminishing diameters of the disks either the rotative speed must be constantly increased or the operation would lose something in the speed of production.

A spline is cut the entire length of the arbor; the end of the sheet is inserted, with a strip alongside of it fitting rather tightly, and at the outside when in place corresponding to the circle of the arbor. The arbor is then rotated until the entire sheet is tightly wound around it and the cutting begins. The tool is fed along by a screw with a ratchet wheel on the end and a pawl on the end of the arbor.



MACHINE FOR MAKING FINE METALLIC SHAVINGS.

The machine here shown was designed and is used not for cutting steel and producing steel wool, but for cutting sheet zinc into shavings, which are largely used in the "cyanid" process of gold extraction. The sheets are about 7 feet long by 18 inches wide. When the sheet is wound on

the arbor the loose outer end is secured by solder. The speed of rotation is from 200 to 250 turns per minute. The sheets may be as thin as .002 inch, and if the feed is the same, it is evident that very minute shavings are produced. The patentee is August Holden, San Francisco.

Roumania's Trade in Machinery and Tools.

It is a widespread opinion among American manufacturers that the general business conditions in the Balkan States leave so much to be desired, that almost all commercial transactions are connected with more or less risk. This, however, is quite a wrong point of view, and it is certainly safe to say that, as a whole, business in most of the Balkan States, if properly conducted, can be regarded as safe as that in Central and South American Republics. If business really were so unsound in the Balkans, there would not be as many large firms in Germany, Austria, and France, which confine their transactions exclusively to those countries. Besides this, business morality has risen in the East, at least in commercial circles. So far, the margin of profits has been narrowed by the competition of the nations of Europe. There are quite a number of solid houses in the Balkans which are careful to fulfill their obligations. These are generally the most important firms, who do not play tricks for the sake of business. It should, above all, be remembered that a house which demands credit is not on that account of doubtful reputation. In a country with little capital the rate of interest is naturally high. The most solid firms often find it advantageous to defer their payments as long as possible. Undoubtedly it would be desirable to do a cash business, but in order to induce a customer to pay cash, a liberal discount should be offered to him. The Balkan markets should by no means be neglected by American manufacturers. Most of the larger cities are constantly progressing, new railways are under way of construction, electricity is coming more and more to the front, and requirements of a more refined mode of living, even of luxury, are beginning to appear. Austria, Germany, France, Belgium, Great Britain, Italy and Switzerland, have not been tardy in recognizing the advantages of commerce with the Balkan States, and all difficulties can be avoided if the exporter is cautious and is represented on the spot by an honest and reliable agent. The writer, has, for many years, regularly visited all of the Balkan States—Turkey, Roumania, Bulgaria, Servia, Greece and Montenegro—but has found no particular difficulty in dealing on a sound basis with the merchants and manufacturers of these countries.

Of all the Balkan States, Roumania is by far the most progressive. Under the goverment of an enlightened king the country has made steady progress, and its industries are well under way. The trade is chiefly in the hands of Germany, Austria-Hungary and Great Britain. To the total imports of the country, about $20,000,000 worth is contributed by Germany, $19,000,000 by Austria-Hungary, and $15,000,000 by Great Britain, while our direct share does not amount to more than $200,000.

If it is, however, considered that Roumania imports every year about $13,000,000 worth of iron, steel, hardware and machinery, it will be apparent that the market is well worthy of our closest attention. In 1898, the last year for which official statistical returns are at hand, the importation of steam engines, electrical machinery, gas engines, agricultural machinery and all kinds of other industrial machinery, amounted in value to about $5,000,000; during the same year separate parts of machinery were imported to the value of $800,000, agricultural implements (with and without handles) to the value of $300,000, and small tools to the value of $850,000.

As far as the principal items of these imports are concerned, the following may be said:

An increasing demand exists for all kinds of agricultural machines and implements. The Roumanian farmers have abandoned their old system of using only their arms in working the land, and have begun to use improved machines and implements on a larger scale. Roumania is one of the principal wheat producing countries of Europe, and the number of farmers is very large. The necessity of agricultural machinery is becoming more and more felt, and the farmers are well aware of the fact that they must do their utmost if they want to continue to compete with Russia. Up to the present time the great bulk of agricultural machinery has been imported from Germany and Great Britain, but especially in this item we should be able to capture a good share of the Roumanian trade. An increasing demand exists for agricultural steam engines, of which some $160,000 worth were imported from England. Machinery and implements most in demand besides steam engines from 12 to 16 horse-power are threshers, harvesters, binders, harrows, weeders, plows, corn planters, rakes, sorters and cleaners. Marshall Sons & Co., of Gainsborough, and Clayton & Shuttleworth, of Southampton, are the leading English shippers, while the bulk of German machinery is supplied by Eckert & Co., of Berlin; Hollingworth & Co., of Cassel, and Rud. Sack, of Leipzig, the latter sending especially steel plows.

Great progress has also been made in the Roumanian sugar industry. The machinery is either of German or French origin, the principal suppliers being the Maschinenfabrik Grevenbroich, of Grevenbroich, Rhenish Prussia, the largest sugar machinery making concern on the Continent, and the Compagnie de Fives Lille, France. It is reported that quite a number of new sugar mills are contemplated. The soil is well adapted for the cultivation of the beet root.

That Roumania is a great petroleum producing country, is a fact well known in the United States. Up to the present time the machines used in the Roumanian oil industry, with few exceptions, have been imported from Austria or Germany, though there should be a first-class market for our manufacturers. New wells are constantly being exploited and new shafts sunk, and it would doubtless pay our makers to give some more attention to that market than has hitherto been the case.

The country is also rich in mineral deposits, and a considerable number of mining concessions have been granted during the last two years. The machinery, so far, has chiefly come from Germany.

Sawmill and wood-working machinery is also in good demand. One of the principal suppliers, not only of Roumania, but of all the Balkan States, is the firm of E. Kirchner & Co., of Leipzig. Sawmills are numerous, and the lumber trade of the country is considerable and steadily growing.

As a natural consequence of the important wheat crop of the country, the milling industry has assumed large proportions. It is estimated that the daily output of all Roumanian mills amounts to about 900 tons of flour. It is exported all over the Balkans. There are about 105 mills in the country, and if they were equipped with better machinery the production could not only be improved, but also largely increased. The machinery is, in many cases, antiquated, though during the last few years a number of mills got a new mechanical outfit, imported chiefly from Germany and Switzerland.

Roumania has at present four paper mills, of which the "Letea Paper Mill," of Letea, is the most important. The production is confined to common newspaper. It is said that two new mills are contemplated. There are at the present time some sixty-five distilleries in the country, all doing a large trade. Other industries carried on to some extent are those of candles, soap, cordage, beer brewing, etc.

It will be seen from these remarks that the demand for all kinds of machinery is considerable, and that the Roumanian market is well worthy of our closest attention. There are also a few engineering works in the country—the principal one being in Bukharest, the capital. The tools used there are of German origin. Small tools, such as files and rasps, saws, hammers, bits, chisels, in short, all kinds of carpenters', blacksmiths', tinsmiths', and the like tools, are imported in large quantities from Germany, England, and Austria. We may also mention that the Roumanian Government has appropriated large sums for the extension of the rail-

way net of the country, and for the construction of new public works, and according to all probabilities the demand for machinery will continue to grow.

H. L. G.

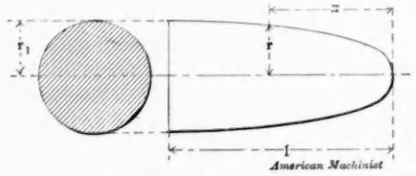
A Diagram for Varying Shaft Diameters.

BY A. E. DIXON.

It sometimes happens in designing a machine that a shaft has to be of different diameters at various points in its length, and it is desirable to keep the fiber stresses as nearly uniform as possible. The theoretical shape for this case is a paraboloid of revolution generated by a parabola whose equation is $y = a x^3$, which is the cubic parabola. The radius at any point is found by the equation

$$r = r_1 \sqrt[3]{\frac{x}{l}}$$

in which the notation is as given in the sketch.



NOTATION OF FORMULA.

The accompanying diagram gives a graphic solution of this last equation. Its

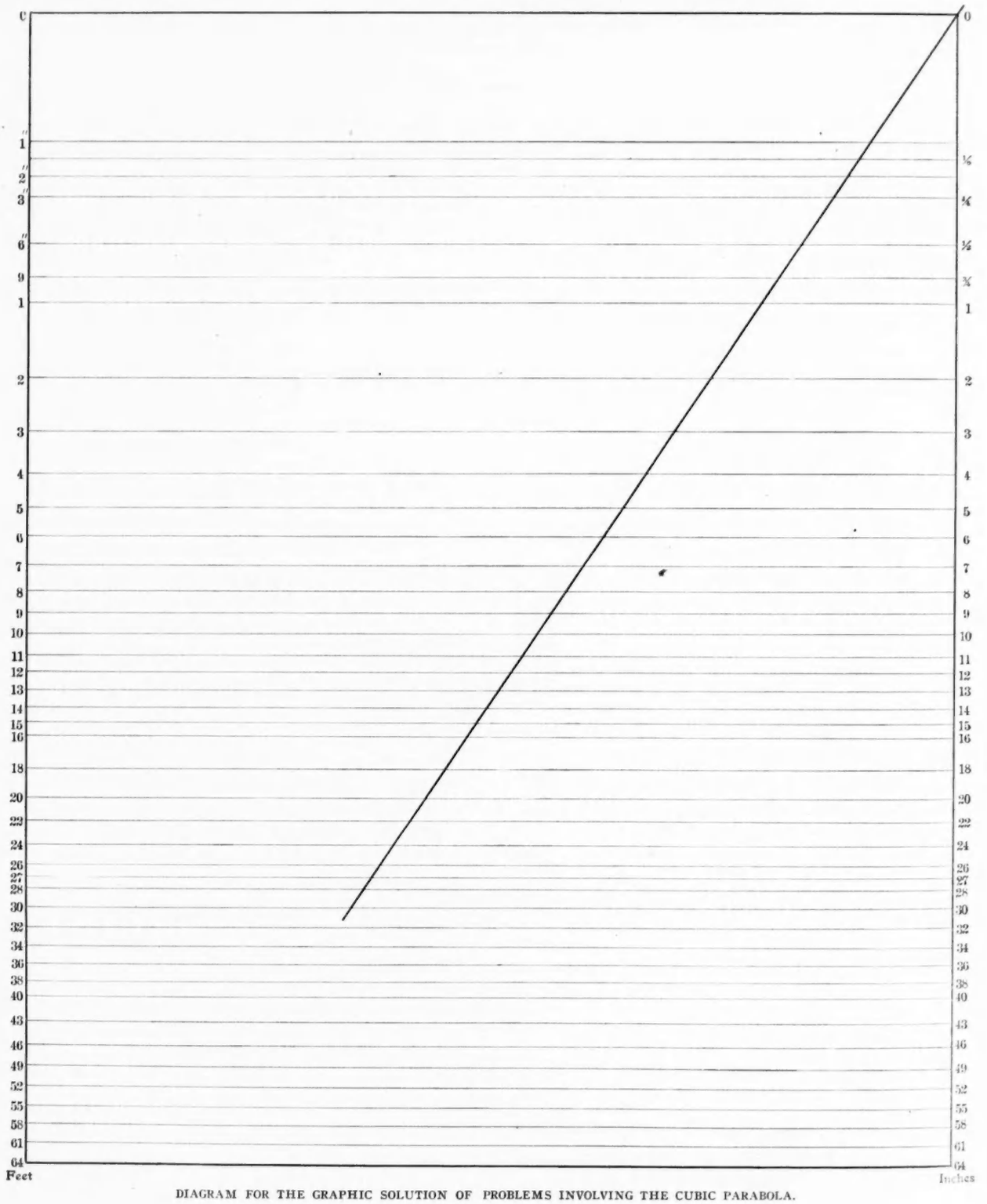


DIAGRAM FOR THE GRAPHIC SOLUTION OF PROBLEMS INVOLVING THE CUBIC PARABOLA.

use is best shown by example. Given a shaft 4 inches in diameter at point of load, 26 inches from the center of the bearing. Starting on the right-hand scale line at 26, the diameter, 4 inches, is laid off. From the point found a diagonal is drawn to the zero point, and the distance from this diagonal to the scale line at any intermediate point gives the proper diameter of the shaft at that distance from the center of the bearing. Thus at 7 inches from the center of the bearing the diagram scales 2 19-32 inches—the diameter calculated by the formula being 2.58 inches.

The construction of this diagram is very simple, the distance to any cross line from the zero point being equal to the cube root of the number marking that line multiplied by a constant. The constant is used to obtain a clearer result than can be obtained by using actual roots, which bring the lines too close together. The constant used in the present diagram is 2. Better results can, however, be obtained in a larger diagram.

[The case given by Mr. Dixon is not, perhaps, of very frequent occurrence, but the construction of the diagram is applicable to many other uses.—Ed.]

Tools for Interchangeable Work—II.

BY JOSEPH V. WOODWORTH.

MAKING AN OVAL SHOE.

The punch and die shown in Figs. 1 and 2, respectively, were for producing the piece shown in Fig. 3. This was used as a shoe for the base described in the previous article. The blanking, both outside and inside, was all done at once; the piercing of the holes was another operation. The die, which was made first, consists of a blanking die *A*, a forging of machine steel with a tool-steel ring for the cutting edge. After being faced on the back, it was set up in the horizontal milling machine and milled all around the outside and then on the inside, leaving the bottom perfectly flat and the cutting edge to the size of template. It was then relieved about ⅛ inch straight; after that it was removed and finished all around the inside by draw-filing and left shearing, cutting first at both ends. The piece *B*, which was an internal punch, was made of tool steel, finished in the miller and afterwards filed to the size of the inside of the template. It was hollowed out in the center, as shown in the cross-section. The template was then placed within the die, and the internal punch within the template, thereby locating the latter correctly. The holes were then drilled and reamed for the dowel-pins *E E*. After they were let in, the holes for the four flat-head screws shown were drilled and tapped. The die *A* and punch *B* were then hardened and drawn, the die to a light straw and the punch to a blue. After the face of each was ground, the gage and stripper pins, not shown, were let into the machine-steel base. The spring pad or knock-out C, of ¼-inch flat machine steel, was made to fit between the inside of the die *A* and the outside of the internal punch *B*. Eight spiral springs, good and stiff, were then made and let down 3-16 inch into the base, and left long enough to just carry the pad *C* to a level with the cutting edge of the die. The die was then complete, and we were ready for the punch.

The punch, Fig. 2, which acted both as a punch for the outside of the blank and as the die for the inside, was made of a tool-steel forging, which, after being chucked, was bored and reamed through the stem large enough for the stem *J* of the knock-out pad *H;* then after being put on a mandrel between centers it was faced off on both sides and the stem finished. It was then milled outside and inside to the size of the template, leaving about 1-64 inch margin all around, then held in the press, and gradually (with frequent filing and milling away of surplus stock) sheared into the die. It was then relieved all over, so as to be an easy, free fit without play in the die and over the internal punch. Two holes were then drilled, about ¼ inch in depth, to act as seats for the two knock-out springs *I I*. It was then carefully heated to an even cherry red and quenched, being particular to dip straight, thereby eliminating as far as possible the tendency to warp or change. Then, after being drawn, the face was ground, and any tight spots eased up. The knock-out pad *H* was then made, fitting the inside of the punch loosely, of machine steel, and a hole drilled and tapped in the center for the stem *J*, which also was made of machine steel, with the adjusting nuts *K K* on the upper end. The two knock-out springs of good, stiff wire were then made, and the various parts assembled and set up in the press.

The punch descending cut the outside of the blank within the die *A*, and the internal punch *B* forcing the inside of the blank up into the punch. The punch then rising, the spring pad *C* in the die throws out the blank and the pad *H* in the punch throws out the piece cut from the inside, thereby making a complete blank in one die at one stroke.

The die for piercing the eleven holes shown in the blank, Fig. 3, was made in the following manner. A bolster of cast iron was got out, and one of the blanks was drilled, the holes being transferred from the jig shown in article No. 1, and a gage plate of ⅛-inch flat cold-rolled stock made so that the blank would just fit in it. It was then fastened to the face of the bolster with screws and dowels, the blank laid within it and the holes transferred through it on to the face of the bolster. These holes were then enlarged for bushings of tool steel, ⅜ inch diameter, which had been turned, drilled and reamed to the size of a clearance drill for a 6-32 screw, hardened and drawn, the face ground and then driven into the holes. They were made in this way to facilitate grinding, and, in case of chipping or shearing, to enable replacing with others. The holes for the punches were then transferred through these bushings on to the face of the cast-iron holder, the punches all made and finished and fastened into the holder, then a spring pad of 3-16 inch flat steel fitted over these, and working up

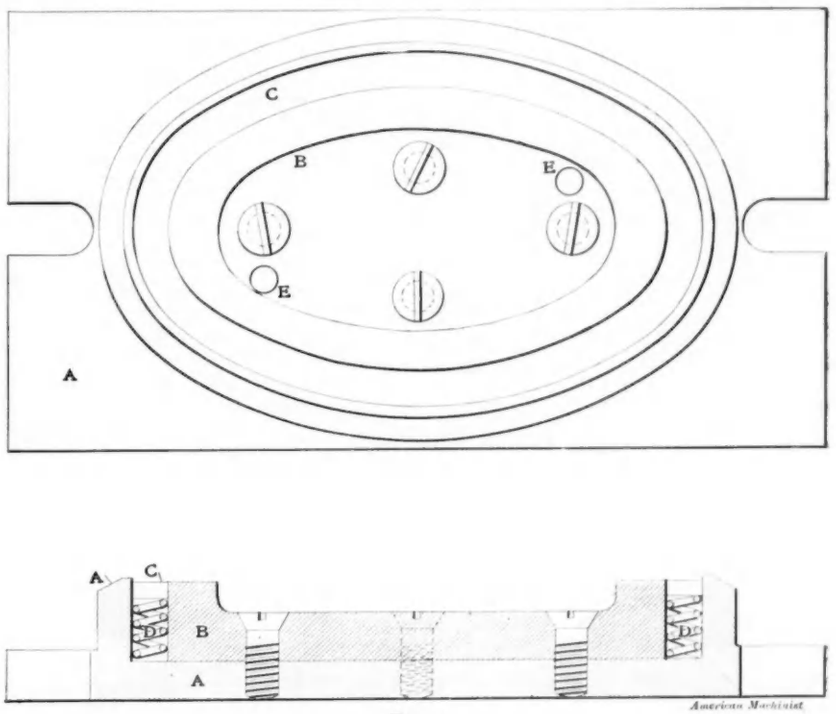


Fig. 1

DIE FOR SHOE.

and down on two studs equipped with strong springs, which acted to strip the blank from the punches after the holes were pierced.

Letters from Practical Men

Circulation in Water Tube Boilers.

Editor American Machinist:

Mr. W. H. Harrison's letter on the Belleville boiler, in your issue No. 32, which should, I think, be No. 604, contains some pertinent remarks on the water-tube type; which remarks I desire to supplement to the extent of asking: Why circulate the water in such boilers—that is, why circulate it beyond one cycle? It has become a settled idea, or rather has remained from the first a settled idea, that a body of water should race around through its cycle, giving up at each turn a portion that is evaporated, the rest going on round and round like a kitten chasing its tail. To put this matter in another way, why should water circulate upward in a steam boiler, to be again sent down or toward the hottest part of the furnace?

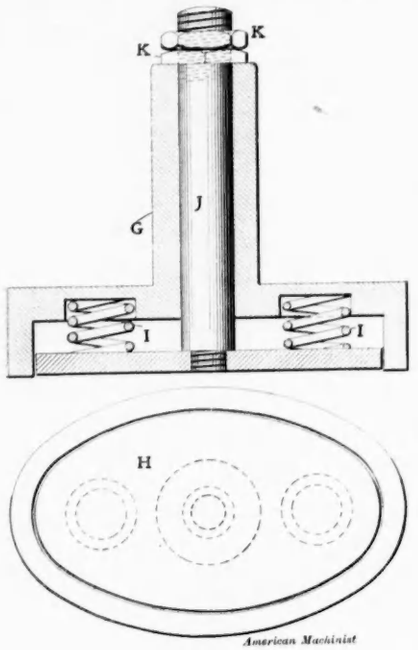


Fig. 2

PUNCH FOR SHOE.

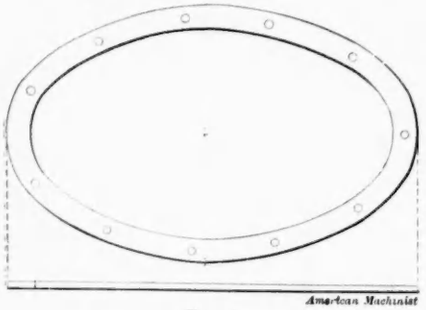


Fig. 3

THE BLANK TO BE MADE.

It seems logical that the water should be furnished as fast as evaporated and no faster, the steam flow upward and the supply water downward. Such a proposition may seem revolutionary, and it is, in respect to common practice; but as to fact it is not revolutionary at all. The writer has seen such a thing, and expects to see it many times again.

Suppose in the diagram, Fig. 1, that *A* is a superimposed drum, *B* a water down-take pipe, *C* the region of chief evaporation, *D* a steam uptake pipe, *F* the water level and E a check valve closing inward towards the drum *A*.

Suppose next that heat is applied at *C* and evaporation begins. There can be no flow up the tube *B*, because of the check-valve *E;* consequently the steam must go up the tube *D*. At the beginning, the static head of water was balanced throughout and no tendency to flow in any direction, but as soon as the water in the pipe *D* is displaced in part by steam there is a gravity force impelling the water in the direction of the arrows, in proportion to the difference in weight of the columns in the two pipes *D* and *B*.

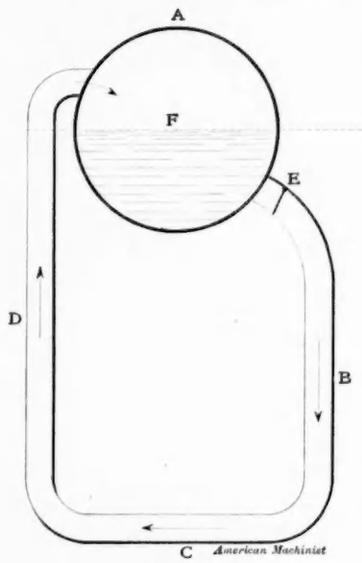


Fig. 1

CORRECT CIRCULATION IN WATER-TUBE BOILERS.

Steam generated in the tube *B* will be carried forward, and the whole operation the reverse of the Belleville and other boilers of the kind; that is, the supply water does not flow from the hottest to the coolest part of the furnace, but the reverse. If water is driven out of the tubes at C there is a head up to *E* to replace it, and the "fact" is that when the tube *D* is not so small as to cause entrainment of water by the rising steam, none passes up that way.

"Burn the tubes," is the first suggestion. Answer—It does no such thing; on the contrary, they are as safe as when the water is supplied at the bottom; and not only this, there is a marked economy in effect, as is proven by practical working of the system under skilled observation. The distinguishing features are that no water is carried up to flow down again, and there is a correspondence of what we may call the temperature diagrams between the furnace and boiler.

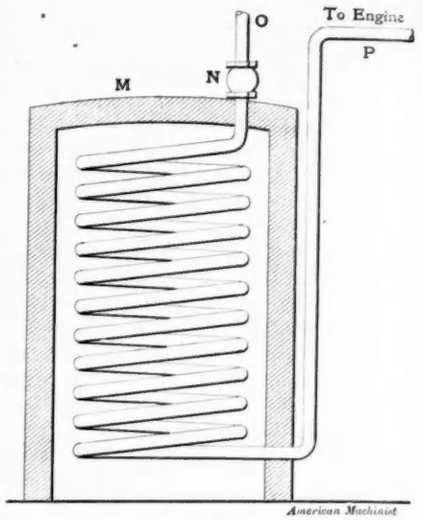


Fig. 2

MR. PARKER'S EXPERIMENT.

To better illustrate this, I will revert to some experiments made some time ago by Mr. J. C. Parker, of San Francisco, who placed a coil of thin pipe in a hydrocarbon heated furnace, as shown in Fig. 2, and connected the pipe O to a small engine, water being supplied through the pipe *P*. This corresponds to a common water-tube boiler, but from intensity of the heat and other causes the water was blown out and the coil burned. He then put a check valve at *N* and reversed the boiler by connecting the pipe *P* to the engine and supplying water through the pipe *O*. This was considered a joke on the experimenter, but it turned out no joke at all—on the contrary, a complete success.

The operation seemed anomalous, and Captain Parker made a small boiler with translucent generating tubes of glass, so the action of the water and steam could be observed. To witness the working of this was to settle all doubts as to the complete regularity and reliability of action. The diagram in Fig. 1, while it does not so well as the one in Fig. 2 explain the reversed circulation, suggests more nearly the construction of working boilers since made on this system.

The writer, if he were to erect a steam-power plant for himself, would buy, first thing, a Lancashire boiler with about a cubic yard of contents for each horse-power and then "build other things around it." The boiler problem would then be settled for one lifetime; but if a water tube had to be employed, I would certainly not circulate the water from the bottom upwards in the generating tubes.

J. RICHARDS.

San Francisco.

Saving Time in Turning Crank Shafts.

Editor American Machinist:

The crank shafts here referred to were solid cranks, such as are generally used on small stationary engines. They were made ten or twelve at a time. The centering of the forgings having been done in a crude and expensive way, and occupying, as it did, the lathe for ten or twelve hours on each lot, it was determined to have a centering machine.

As it was impossible to find on the market one that would accomplish what was wanted, a new one was designed and built. This machine had in the headstock two spindles, one within the other. The inner one extended back through the outer one, and was driven by a pulley on a feather, the pulley being held in a yoke, and the spindle moved back and forward through the pulley and outer spindle by a hand lever. This inner spindle carried a combined drill and reamer. The outer spindle was carried in the lathe head and was strongly geared. It was supplied with a flat cutter, which was placed in a slot in the front end. By sliding the inner spindle forward, the cutter could be pushed out of place allowing the center drill to be used. The bed of the lathe carried a long carriage on which was mounted a turntable, supplied with two chucks, the jaws of which were moved to and from the center of the machine by means of right and left hand screws. These jaws were similar to those of a pipe vise, and were always at equal distances back and front of the center of the machine. The heads carrying the jaws could, also, be moved to and from each other lengthwise of the machine to accommodate long or short work. The carriage had a rack and pinion hand feed. The bed plate was cast with an oil reservoir, a pump supplying a flood of oil to the work.

The operation of this machine was as follows: The heads carrying the jaws were placed the proper distance apart to catch the forging about midway between the belt and the ends, and the jaws were drawn together, gripping the piece firmly. The cutter was placed in the slot in the outer spindle and the carriage was fed forward, bringing the end of the shaft against the cutter, thus squaring the end. The carriage was moved back, the inner spindle was brought forward, pushing the cutter out of the slot in the outer spindle, and thus allowing the center to be drilled and reamed. The turntable was then rotated one half turn, and the other end of the shaft was squared and centered. The entire operation required less than ten minutes, practically abolishing the cost of centering, the work being done by the lathe hand while the roughing cuts were made on the body of the shaft. The machine was also used for centering various other pieces; in fact, it did nine-tenths of the centering work of the factory.

The operation of slotting the forging and the method of turning the crank pin being slow and expensive, a machine, or rather, a special lathe was designed and built, which obviated the necessity of slotting, and also of fitting the temporary arms to the ends of the shaft for centers on which to turn the crank pin. This lathe consisted of a heavy bed plate or shear cast with an oil reservoir, and was in the shape of the letter L, the short arm of the L extending back of the headstock, and carrying the cone and gearing. Fig. 1 represents the spindle and tailstock with forging in position for turning the crank pin. The spindle was 25 inches in diameter, and was hollow, the hole through it being 18½ inches in diameter. It was cast with a face plate on it 36 inches in diameter which formed a spur gear of 5 inches face, the teeth of which were cut. This face plate was provided with a slot 6 inches wide and 19 inches long. On each side of the slot, and running its entire length, projections were cast in which were placed heavy set screws *B B*. On the back end of the spindle was fixed a yoke *X X*, in which was fitted a sliding head *W* carrying a center *Z*, which was movable to and from the center of the spindle. The sliding head also could be moved back and forth in the frame by means of a screw and a hand wheel at the back, and could be fixed at any point desired. The head was accurately graduated, so that the center *Z* could be located at any desired point, according to the throw of the crank from the center of the spindle, and firmly fixed. The head was strongly geared and provided with a quick change from the slow strong motion used in turning the crank pin to the faster motion for the body of the shaft.

The tailstock was made with a revolving spindle *N* geared to run in unison with the spindle of the headstock. It had on its front end a face plate having a slot in which was a movable center similar to that in the frame on the back end of the spindle, and which was manipulated in the same way.

Both the longitudinal and the cross feeds were by power. The tool-carrying head *M* was arranged with a narrow support extending out under the tool *P* to support the long tool used in turning the crank pin.

Care was taken to make this machine perfect in every way and strong enough to stand any strain that might be brought on it. The function of this machine was not only to turn the body of the shaft, but also to turn the crank pin, cutting it from the solid forging, instead of slotting out the center. After the forging was centered, it was placed in this lathe and the pin turned. This being a 10-inch throw crank the centers were set 5 inches from the center of the spindle, the one on the back end being placed at the proper distance from the face plate to allow the body or web of the forging to project from between the ribs or lugs of the face plate sufficiently to form the crank pin. The tailstock was set at the proper distance from the face plate to receive the shaft. The shaft was then picked up by the air lift, one end was passed through the slot in the face plate and placed on the centers, the web being centered in the slot by the set screws. In this position the stock in the forging to form the crank pin was central with the lathe spindle. A tool was then placed in the tool holder, the supporting block *Q* first having been dropped into position, the width of the tool being 1-16 inch less than the width of the crank pin. The amount of stock to remove, in this case, was 5 inches long, 3 inches wide, and 3½ inches thick. A feed of one thirty-second of an inch was used in making the first cut. After the stock was cut away and the pin brought to within about 1-16 inch of its finished size, the roughing tool was taken out and

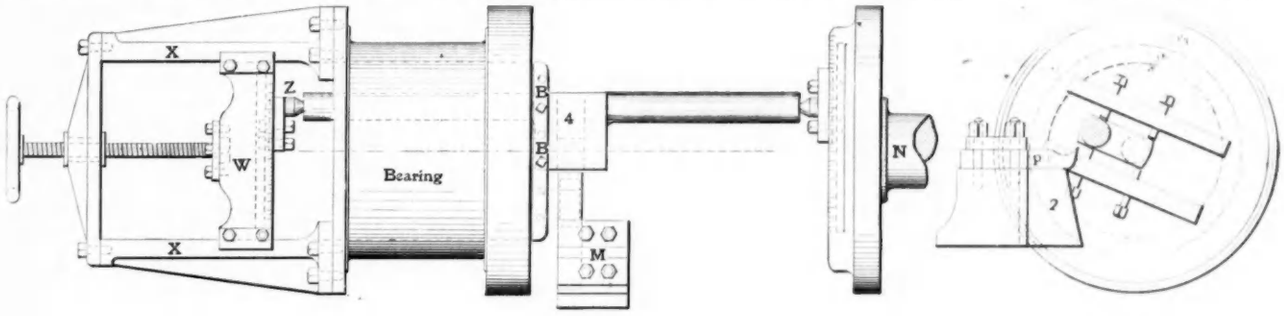


Fig. 1 Fig. 2

RIG FOR TURNING CRANK SHAFTS.

the set screws holding the crank in position were loosened to allow the shaft to resume a natural position free from the spring that the cutting away of the stock might have caused. The screws were again tightened with care, but not *too* tight. A finishing tool was then put in position, cutting down both sides of the throw, forming the fillets and finishing the pin. All the work being done under a flood of oil admitted of quite high speed and heavy cuts.

The pin being finished, the centers were brought back in line with the center of the spindle. The pin turning tool and the tool support were removed and two tools put in for turning the body of the shaft. These tools were of the same class as used in a turret lathe, having a back rest. In this part of the work the fast motion was used with heavy feed and plenty of oil. When one end was finished the shaft was turned end for end and the operation repeated. The work being done in oil, a fine finish was obtained, no filing or polishing being necessary.

The time consumed in turning the shaft was from two and one-half to three and one-half hours. The old method required fourteen and one-half hours to complete a shaft of the size used in a 10x12 engine. By the introduction of the air plant and the new tools the work was done in three and one-half hours; the centering machine also being very profitably employed on other work, every piece centered in it being done in a quarter of the time consumed in the old way.

B. M. T.

A Special Adaptation of the Screw Machine.

Editor American Machinist:

I send you a sketch showing how we adapted the automatic screw machine for some special forgings. Fig. 1 shows one

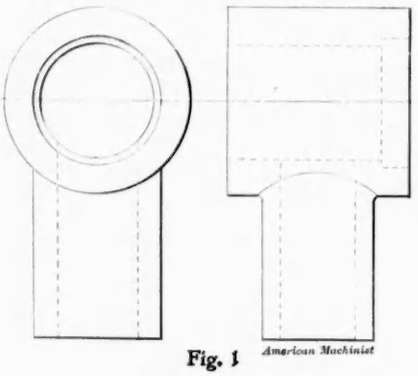


Fig. 1

THE FORGING TO BE BORED.

of the forgings. The large part had to be drilled and reamed two different sizes, and the depth of the large size or counterbore had to be accurate, while the smaller hole ran all the way through. The other part of the forging was drilled at right angles to the first hole.

We first removed the collar in which the ordinary chuck for bar stock is operated, and fitted a larger ring to the spindle. We next counterbored the two-jawed chuck to fit the ring on the spindle and

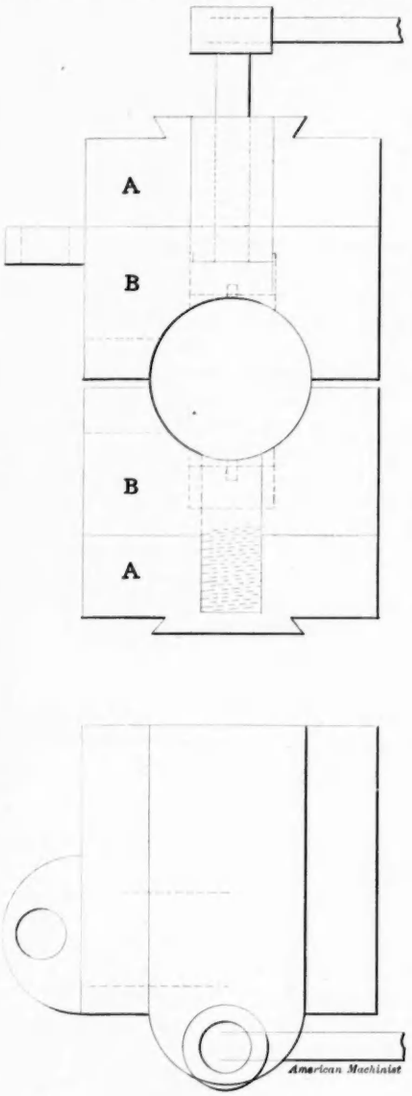


Fig. 2

THE CHUCK JAWS.

fastened both by the four screws originally in the spindle.

To do the two drilling operations in the forging without making a separate operation we made chuck jaws like Fig. 2. Each half was made in two pieces, *A* and *B*, held together by a screw with head in *B*. The top half *A* had two lugs projecting, with a gage pin, so that when one hole was completed, by taking out the pin and turning the part *B* one-quarter way round the forging was in position for the second hole.

Fig. 3 shows the reamer used. The facer on the reamer was bored to fit the large part of the reamer, except the front part, which projected into the flutes of the reamer, which insured a smooth surface, free from any burr.

In order to have the machine stop at the completion of the piece, we made a collar in halves and fastened it on the cam shaft. This collar had a projection which touched a lever which connected with the shipper and stopped the machine. The throwing over of the shipper also made connection for an electric bell, which called the operator, so that no time should be lost.

H. F. D.

Transfer Cranes for the Foundry.

Editor American Machinist:

It is with interest the writer has read Mr. P. R. Ramp's article on Foundry Improvements printed in issue 34. We must agree with the writer of the above named article that unless a foundry has an unusual amount of good luck to fall back upon or a rich uncle to draw upon in case of need, "The first improvement required is a practical mechanic as manager." It is equally true that poor judgment in selecting the proper kind and size of travelling cranes for a foundry can be prevented by having a full knowledge of the requirements.

A good trolley system over each floor is also a point to be carefully considered and the writer begs to call your attention to an improvement in this line which may be of interest to the trade in general.

Instead of using overhead turntables and switches I find it a much better arrangement to have at each end of the tramrails and sometimes between, transfer cranes to transfer the hand or power hoists from one tramrail to another. These transfer cranes are in themselves capable of handling work under them without interfering with the long runs of tramrails.

AUGUST JOHNSTON.

New York.

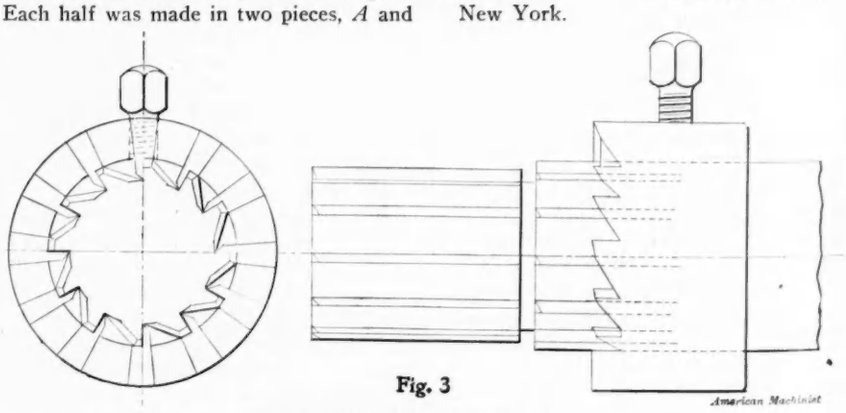


Fig. 3

SPECIAL REAMER AND FACER.

Finding the Radius.

Editor American Machinist:

Following is another demonstration of the formula for finding the radius of a circle when you have the chord and rise given. Referring to the sketch, $c\,d$ = chord, $b = \frac{\text{cho}}{2}$, a = rise. We have:

$$e : b :: b : a,$$

therefore $$e = \frac{b^2}{a}$$

and $$e + a = \frac{b^2}{a} + a = 2R,$$

giving $$R = \frac{\frac{b^2}{a} + a}{2}$$

Here is another one: Let $c\,d$ = stroke of a valve stem, f = distance from the fulcrum of the rocker arm to the center line of motion; what should be the length of the rocker arm if it is to be as far above the center line of motion when in mid-position as it is below it when at the ends of the stroke? Referring to the same sketch, R = length of lever arm. We have:

$$(f - n)^2 + b^2 = R^2;$$

but $$n = R - f,$$

therefore $$(f - n)^2 = (2f - R)^2,$$

and $$(2f - R)^2 + b^2 = R^2,$$

or $$4f^2 - 4Rf + R^2 + b^2 = R^2,$$

or $$4f^2 + b^2 = 4Rf,$$

or $$R = f + \frac{b^2}{4f}$$

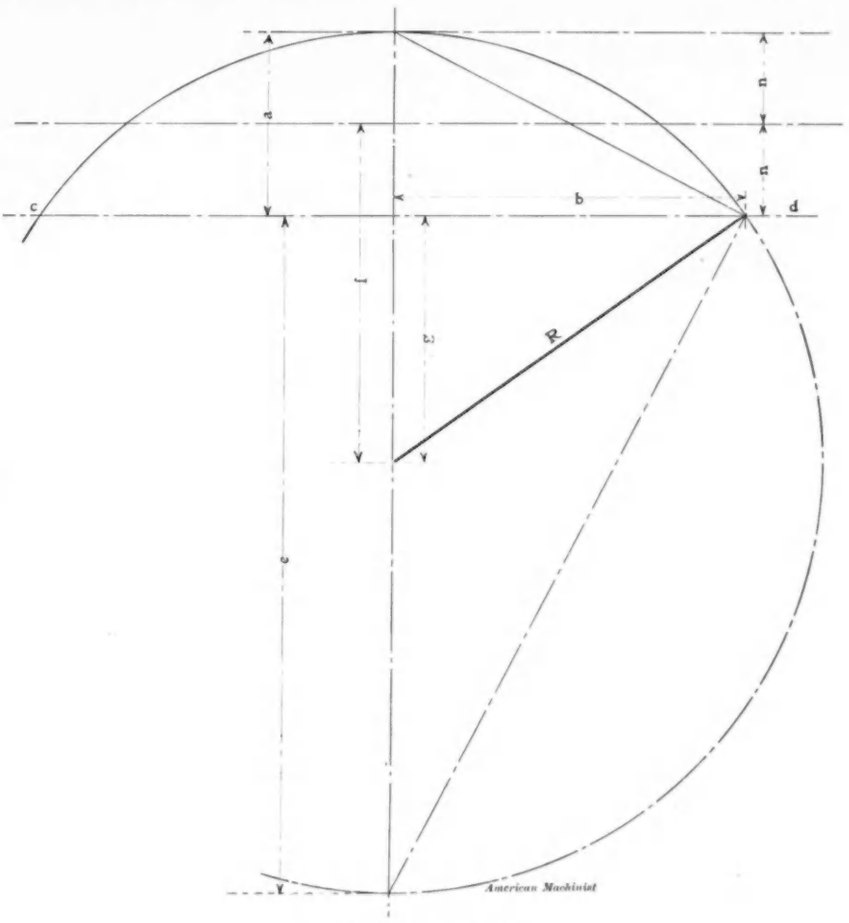
If $$f = 4\tfrac{1}{2},$$

and $$b = 3,$$

$$R = 4\tfrac{1}{2} + \frac{9}{4 \times 4\tfrac{1}{2}}$$

$$= 5.$$

A. GOODFELLOW.



FINDING THE RADIUS.

Slotting Studs in the Milling Machine.

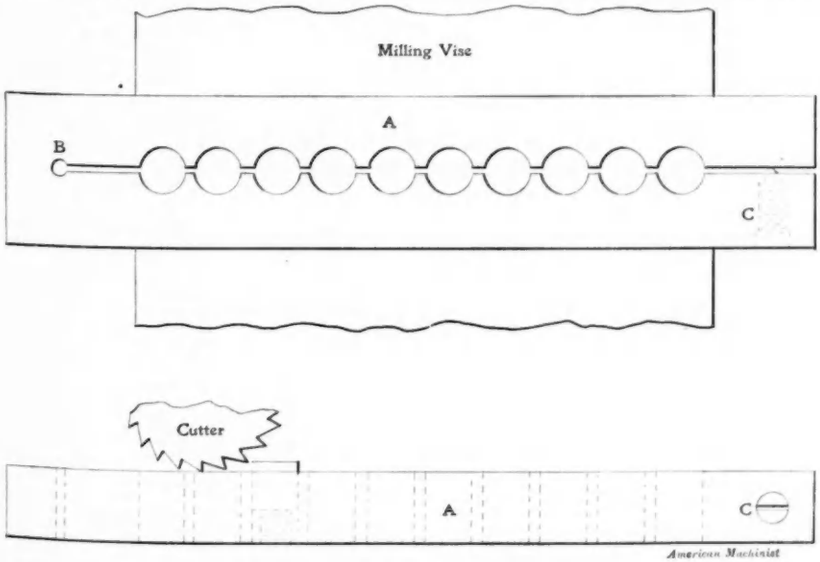
Editor American Machinist:

I was quite interested in the jig illustrated in No. 31 of the "American Machinist" for slotting studs in the milling machine. We have been doing the same thing in a slightly different way, and when I confronted the foreman of this department with Mr. A. B. Christman's fixture, I regret to say that I was rewarded with another "Wouldn't work." On asking a reason for the faith that was in him, he said, "If the holes are easy enough to pick out the studs with the fingers, it won't be long before one of the studs will turn, and then away goes the cutter."

Under the circumstances I could not gainsay him, and so have brought my troubles for solution to you or to the "magicians." We first tried drilling and reaming a row of holes and pressing or lightly tapping the studs into them. This was all right, except the finger movement, and then we would run across a stud a little below size and which desired something a little more artistic than a straight line, and then there was trouble.

Our present practice is to use a holder about like the sketch, in which A is a cast-iron strip suitably planed, drilled and reamed to receive the size stud desired. A thin metal saw is run through the line of holes to B. A small dog-point screw is placed at C to spread for loading; a half turn with a screwdriver brings the screw back. Drop the plate in the milling vise, tighten up and cut away. Provide the operator with an extra one or two to load while No. 1 is in the machine, and with proper attention the cutter can be kept warm.

A. L.



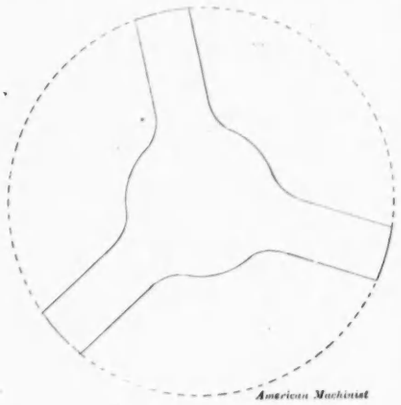
RIG FOR SLOTTING STUDS IN THE MILLING MACHINE.

Center for Laying Out Work.

Editor American Machinist:

I have a great many flanges, gears, glands and such things where I want a temporary center for laying out holes for drilling, and I find it handy to have a lot of centered sheet-tin pieces like the sketch. These are cut on the ends just a little

larger than the regular sizes for the holes, so that they have to be sprung a little to get them in. I put them in so that when sprung the convex side will be outward



TEMPORARY CENTER FOR LAYING OUT WORK.

and then the pressure of the divider point will not move them. As these pieces are already centered, no time is lost in trying for the center. J. SCHURING.

Milwaukee.

Good and Poor Machine Tools.

Editor American Machinist:

To read much of what is written about foreign competition and the condition of English shops and English work, those who did not know the persistent grumbling that goes on here would be disposed to believe that every English workshop was in ruins and that there was no trade left in the country. I sometimes think that the habit indulged in by certain people and certain papers, of decrying everything English, has had a bad effect on some of your American machine toolmakers. When I first landed in America, one of the first cautions I received was to take no notice of the daily papers. The advice was good, and it is good advice to American toolmakers, to take no notice of most that has lately appeared here. The impression conveyed is that all our English shops are so badly off for tools and appliances that anything may be shipped over here and will be better than our best. In a recent tour—I will not say to what country—I called at a growing works, and, as usual, discussed American tools and English tools and methods. I found them, to begin with, well up in work that I profess to know something about. They were doing good work on good designs. They had bought many American tools, and I enquired as to accuracy of make and finish and as to capacity to do what was claimed for them. Our conversation was long; it extended over the reasons why they had gone to America for tools. Questions of quick delivery came up, and we discussed sizes and many other things. The gist of the information I gathered was that the light classes of American machine tools are excellent and, as a rule, accurate, but that the heavier tools are not merely inaccurate in adjustment, but are most inaccurately made; so much so in cases that they would not even work, and main parts had had to be remade over here. There was also the complaint that they would not begin to do the work they were claimed to be capable of doing. In the lathes, for example, the tool-holder and rest generally was most insufficient. Now, this was not the opinion of an amateur or of a man who did not understand work. He had certain tools of Messrs. A & B, whose name I will not give, and he stated that the tools of this American firm would do all they claimed to do; they were strong and accurate. Well-known makers of heavy tools did not appear to be able to do good work, though I believe they have produced many very excellent tools. Another firm of heavy tool makers, whom I will call M & N, however, he declared sent excellent tools every time—accurate, strong and up to their rated capacity—and he got as much out of them as they were claimed to do, even on our harder English cast iron. Now, here was a large user of tools, fully able to get results, not prejudiced against American tools, but praising those of two firms who alone had sent him reliable tools of heavy build. Of the condemned firms I may say that I have received an equally bad report of one of them from an entirely different source, quite independently.

I think that it is quite possible that many American toolmakers have read so much of the depreciation of things English that they have concluded they may send any rubbish over here and it will pass muster. It may not be amiss to point out that in such cases as England has appeared to go back, it has not been so much in the quality of the work done as in the system, or want of system in manufacturing. This is a very different thing. Apart from light machine tools, my friend had received satisfaction from only two American firms, and these two were right every time. Much harm is being done to American interests by those who send tools that have the faults named to me. I could give more detail, but wish to avoid being too clear, for obvious reasons. When a toolmaker begins to think he can dump rubbish here for long, it is time for him to go down to New York harbor and make a tour of inspection of a few samples of British work floating about there. The tools that made these specimens may be slow, but they will need to be accurate. As said above, we have perhaps been slow, but we have not dropped in quality.

I enquired particularly whether the failure to come up to rated capacity was a result in any way of the difference in the hardness and toughness of the material to be worked. My friend thought there might be some little in this, but not much, because, as he had already pointed out, no difficulty was found with the tools supplied by the two makers specially referred to above. This fact appears to sufficiently dispose of the question of material, though there must of course be some effect arising from this. Indeed, there is a general impression that much more care is taken to prepare material in America for easy working; more attention is paid to the pickling of castings, if not also to charging of the cupola, while it is usually understood that the ordinary cast iron to be procured is less hard than what is found here. Special attention seems also to be given to the making of a particularly soft and mild form of steel for spindles and other parts, while such steel is also made nearer to size. Opinions are divided as to whether this special material is altogether for the benefit of the ultimate user. The idea that a machine tool should last until it is worn out has been pretty well exploded, but it is sometimes suggested in reference to the use of what may be termed easy material, that there is no necessity for a machine to wear out before it becomes obsolete, and repair shops here are finding themeselves with repair jobs on some parts of American machinery that has worked but a few months. Obviously the use of easy material is a great economy for the manufacturer, but there is another side to the question. It may be all very well to say that a tool does not want to last twenty years, and need not be made to do so; but given that it should last ten years, is it not a doubtful economy that it should be worn seriously inaccurate in two years? At present the question of materials is largely in the hands of the manufacturer and toolmaker; but it is possible that the neglect of material on this side has not been more at one extreme than the too close attention to its mildness that has obtained in America, where facile working is the rule all round, has been on the other side. We want a more rational practice all round and a better adaptation of means to an end, so that the main wearing parts on which continued accuracy of work or economy in working depend should have a hardness suitable to those considerations.

London. W. H. BOOTH.

[We have published before articles that go over substantially the same ground as the above by Mr. Booth. It is an old story, that accurate and inaccurate tools are made in America, and the same is true of Great Britain. The experience of the British owner does nothing whatever to show whether or not American tools, as a class, are more or less accurate than British tools as a class, but it may show that he had sufficient acquaintance with British tools to select good ones, and not so intimate a knowledge of American tools. It is needless to say, also, that the better class of American tools do not wear out in two years, when used for the work they are intended for and in the manner in which they are intended to be used.—Ed.]

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer by mail.

(23) H. B. B., Edgewood Park, Pa., sends a sketch of a hollow float with a stem or neck, the float being supposed to float in water with the neck extending above the surface, and says: Suppose the float to be placed in a steam boiler supplied by a feed pump in the usual way. The stem being open above the water level, the pressure inside and outside the float is the same at all times. Assume an initial steam pressure of 250 pounds, which is reduced by consumption of steam to 200 pounds, and there is a consequent precipitation of the water held in suspension in the steam, inside both boiler and float, proportional to the decrease in temperature. Now, A claims that upon a subsequent rise in temperature, the water in the float will be evaporated first, and water for subsequent evaporation will be supplied by the feed pump, for the reason that the water in the float is hotter than the feed water. Thus

(*Continued on page 42.*)

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Gear Wheels, gear cutting. Grant; see p. 20.

Dies & punches. Amer. Hdw. Co., Ottawa, Ill.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Forming lathes. Mer.Mach.T.Co.,Meriden,Ct.

Punches & dies. Wal.M.Wks.,Waltham,Mass.

Light and fine mach'y to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Book "Dies and Diemaking," $1, post paid. J.L.Lucas,Bridgeport,Ct. Send for index sheet.

F. J. Stokes Machine Co., 13th and Noble sts., Philadelphia, Pa., build light machinery.

Wanted—7-foot boring and turning mill, modern design. The Murray Iron Works Co., Burlington, Iowa.

Selden Packing for Stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., New York.

Manufacturer wanted for medium weight machinery. Address "Established Line," Box 292, AMERICAN MACHINIST.

For Sale—One second-hand Backus gasoline engine, 25 H.-P.; used about 3 months. Address H. M. Williams & Co., Attleboro, Mass.

Threads and gears; easy rules to cut any thread possible to be cut in the lathe, without algebra, sent to any address for 25c. by G. W. Dixon, Spring Lake, Mich.

Machine shop for sale in the eastern part of Wisconsin, doing a general repair and jobbing business, also selling engines, boilers, machinery, etc. Box 306, AMER. MACHINIST.

Institutions retiring from business having machine tools, brass and wood working machinery will find it to their interest to correspond with us. We purchase complete plants or handle them on com. C. C. Wormer Mach. Co., 55-59 Woodbridge st., W., Detroit, Mich.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded; but replies will be destroyed without notice. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents.

Situations Wanted.

Draftsman wants a position. H. Westling, 439 Henry st., Brooklyn.

An experienced draftsman wants a position. Address Box 313, AMERICAN MACHINIST.

Draftsman; age 28; technical graduate; 10 years' general experience. Box 305, AM. M.

An experienced draftsman and designer, 30, wishes responsible position. Box 283, AM. M.

All-around machinist, age 24, 9 years' experience, wishes position; shop or traveling. Box 303, AMERICAN MACHINIST.

Assistant superintendent of shop employing 200 machinists, desires a change. Address Box 312, AMERICAN MACHINIST.

Draftsman with mechanical experience desires position with an up-to-date concern. Box 310, AMERICAN MACHINIST.

Toolmaker and draftsman of ability and experience desires position; preferably as foreman; references. Box 311, AMER. MACH.

Competent gas-engine designer, well posted and reliable, will be open for engagement October 15; technical graduate; energetic. Box 308, AMERICAN MACHINIST.

A practical man of wide experience wishes to correspond with Eastern manufacturers with regard to opening Chicago agency for same. Box 301, AMERICAN MACHINIST.

Wanted—Position as foreman in machine shop, by a thorough, practical mechanic; up to date in modern shop methods and can handle men successfully. Box 300, AM. M.

Position as superintendent in plant manufacturing light interchangeable metal work; 20 years' experience brass work, sewing machines and bicycles. Box 287, AMER. MACH.

All-round machinist, sober, industrious, used to accurate work, 25 years' experience, wants position where he can get contract work, with or without help. Box 307, AM. M.

Wanted—Situation as superintendent or foreman, by up-to-date toolmaker and machinist; 20 years' experience handling help; don't answer if you want a 35-year-old man. Box 304, AMERICAN MACHINIST.

Wanted—Position, by young man, thoroughly competent, with 12 years' experience as chief clerk and assistant secretary in a large locomotive and engine works; best references. Address Box 299, AMER. MACHINIST.

Wanted—Position as superintendent, by thorough mechanic, 35, with some concern who desires to establish a system of interchangeability; well up in special tool and die work; correspondence solicited; A1 references. Box 302, AMERICAN MACHINIST.

A well-connected mechanical engineer will be open for a position as solicitor and superintendent of erection of machinery (specifications included) with some good engineering company in a foreign field; Japan preferred; excellent references. Box 318, AMER. MACH.

All-round machinist and toolmaker open for engagement as foreman or superintendent; has successfully held similar positions; experienced on engine, electrical machine tools, automatic machinery and up-to-date methods of getting out work. Box 309, A. M.

Position in machinery sales department wanted by technical graduate; 9 years' business experience; thoroughly familiar with all details of office work and management; at present employed in similar capacity with large manufacturing company. Address Box 315, AMERICAN MACHINIST.

General superintendent and machine works manager; 30 years' practical experience; expert draftsman; highest references from past and present employers; experienced in printing presses, webs, stop cylinders, two-revolution, jobbers and lithograph; hydraulic machinery, steam and power plants, machine tools also in specialties; correspondence solicited with parties requiring a first-class man either as superintendent, manager or manager of sales department. Address Box 286, AMERICAN MACHINIST.

Man of originality, technical education, a practical machinist, with more than ordinarily valuable experience, as master mechanic and superintendent, open October 1; capable of directing general construction; familiar with every detail of power and transmission; up to date in modern shop operations and management; can design jigs and methods; understands foundry and patterns, drafting and accounts. Clear head, good hands, energetic, adaptable, systematic; has character and reliability; prefer vicinity of New York. Address Box 316, AMERICAN MACHINIST.

Help Wanted.

Wanted—A good machinist for light work. Address Wheeling Mold & Foundry Co., Wheeling, W. Va.

Wanted—Young man as mechanical draftsman, with technical education preferred. Address H. D. Johnson, South Bend, Ind.

Draftsmen desiring extra money, state where employed, confidential. Edwin Guthrie, Corcoran Building, Washington, D. C.

Wanted—Machinist and draftsman; one familiar with paper-mill machinery preferred; state experience and salary. W. M., care AMERICAN MACHINIST.

Wanted—Operator to take full charge of seven Hartford automatic screw machines; first-class pay to first-class man. Address Box 295, AMERICAN MACHINIST.

Wanted—A few first-class mechanical draftsmen; in applying furnish statement of past experience and references. General Electric Co., Schenectady Works, N. Y.

Wanted—A competent machinist who is able to go out and take charge of the erection of machinery; state references and age. Reply to Box 298, AMERICAN MACHINIST.

Wanted—Machinist to take charge of shop in Rochester, N. Y., employing 25 hands and growing fast; must be up to date; give experience, reference, age, etc., A. L. G., AM. M.

Foreman for shop employing 35 hands, doing repairs and building small machine tools; must have experience in latter line; state age, references and salary wanted. W., care A. M.

Wanted—Experienced toolmakers for armature and pole dies, jigs, fixtures, etc., in a large electric manufacturing works near New York city; state experience. Box 288, AMERICAN MACHINIST.

Draftsman; first-class man, experienced in machine-tool design, also D. C. motor work, especially direct connection; state age, experience and education; Chicago firm. Box 314, AMERICAN MACHINIST.

Wanted—Draftsman and designer for a concern manufacturing machine tools, located in northwestern Ohio. Address, stating age, experience, references and salary expected, Box 293, AMERICAN MACHINIST.

Wanted—Draftsman for our crane department, to work under direction of chief draftsman; a man of at least 2 or 3 years' experience in this or similar line is desired. Industrial Works, Bay City, Mich.

We are enlarging our works, and will shortly require an increased number of skilled mechanics; we invite application from pattern makers, molders and machinists. Address the Westinghouse Machine Company East Pittsburgh, Pa.

Wanted—Mechanic with knowledge of modern shop practice, as superintendent of works manufacturing standard line of machinery, located in Boston, and employing 200 men; state age, experience and where employed. Box 317, AMERICAN MACHINIST.

Machine hand wanted; one who has had experience with large combination boring and milling machines and accustomed to accurate work; $3.25 to $3.50 per day; state where last employed and class of work performed. Address Box 278, AMERICAN MACHINIST.

Wanted—A bright, quick and energetic general foreman for machine shop in Chicago; don't answer unless you have experience on special machinery and have handled men before; references must be good; state age and salary expected. Box 296, AMER. MACHINIST.

Wanted—Machinist; first-class planer and vise hand; only those experienced on woodworking machinery need apply; best of references required; good wages and steady employment to right party. John T. Towsley Mfg. Co., Evans, north of Gest st., Cincinnati, Ohio.

Wanted—An experienced mechanical engineer, competent to take charge of the power, the maintenance of machinery and the general repair work of all kinds, in a large manufacturing establishment. Address Box 297, AMERICAN MACHINIST, giving qualifications and experience.

Wanted—Skilled machinists; men who are good lathe, floor and all-round workmen, and who are steady, sober and industrious; married men preferred who will move to a progressive, up-to-date city, with intentions of holding a permanent job at good wages. Address Woolley Foundry & Machine Works, Anderson, Ind.

Wanted—Machine-shop foreman; must be well posted in the working of brass and iron, also manufacture of tools for same; married, steady, sober and industrious, and be able to furnish A1 references; good position for right man; if not possessed of above ability, no attention will be paid enquiries. Address Box 280, AMERICAN MACHINIST.

Wanted—Foreman for a machine shop employing 75 men on a high-grade gasoline engine; a theoretical and practical mechanic, familiar with modern methods, capable of handling and organizing to the best advantage to reduce costs; state wages and give references; brief replies will not be answered; also a first-class modern-method foundry foreman wanted. Box 294, AMER. MACH.

(Continued from page 41.)

the float will be kept free from water, comparatively speaking, and will retain its buoyancy. B claims that the water in the float will accumulate, and will finally sink the float, but is unable to give any reasons for his stand. Which is correct? A.—We think you are wrong in your initial assumption, that there would be a precipitation of water due to the drawing of steam from the boiler. On tne contrary, the reverse would be true, as the reduction of pressure would leave the water at a temperature above that due to the reduced pressure, and it would boil and give off additional steam. Were there any water in the float initially, it also would boil. It is this reservoir action of superheated water which makes boiler explosions so destructive. The explosion of an air receiver is a mild affair compared with that of a steam boiler, for the reason that this action cannot take place with air. With water in the float initially, there would be very little evaporation from it as there would be too little difference in temperature inside and outside to lead to the transfer of much heat. Without a difference of temperature there can be no such transfer, and without the transfer there can be no boiling. If you suppose boiling to begin the result would be to reduce the temperature which would stop the boiling, but the reduction could only be a trifle and the inflow of additional heat would be correspondingly slow. The matter can be easily tested over the kitchen fire, using a large and small pan of water. It will be found almost impossible to get the water in the inner pan to boil.

Naval Architecture at the University of Michigan.

The great activity prevailing in our ship yards finds a reflection in the work laid out by colleges of engineering. The University of Michigan has arranged to establish a course of study in Naval architecture and has engaged Professor Herbert C. Sadler, late of Glasgow University, to take charge of it. Prof. Sadler has already reported for duty and will commence work at once. He received his training at one of the leading ship yards of the Clyde and also at Glasgow University, of which institution he is a graduate.

For the coming year the course of instruction will occupy the entire Senior year, but the future arrangement will class the instruction as graduate work—beginning at the middle of the Senior year and extending entirely through a fifth year.

New Catalogs.

The Simplex Electrical Company, Sidney and Franklin streets, Cambridgeport, Mass., sends a catalog of electric heating appliances, including kitchen and laundry utensils, stoves, car heaters, etc. Size, 7¼x5¼ inches.

(Continued on page 43.)

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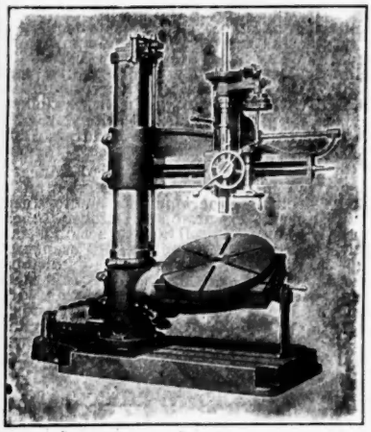

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